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AIR FORCE HUMAN RESOURCES LABORATORY

CAPACITY OF AIR FORCE OPERATIONAL UNITS TO CONDUCT ON-THE-JOB TRAINING
DEVELOPMENT OF ESTIMATION METHODOLOGY

By

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This technical report documents the development and initial empirical testing of a practical methodology for estimating the capacity of Air Force operational units to conduct on-the-job training (OJT). The methodology is based on a conceptual model of OJT capacity that describes the complex interrelationships among the level and quality of mission performance achieved, and the amount and quality of training provided, by an operational unit. The unit's capacity to conduct OJT is then determined as the maximum amount of training sustainable by the unit without compromising established training quality and mission performance standards.

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The model has been empirically tested by estimating its basic structural equations, to the extent possible, using existing data for six operational units. Despite substantial limitations in data availability, the empirical analyses reveal, for all units studied, a persistent and strong inverse relationship between the training load of a unit and the mission performance quality of the unit. These favorable results indicate that further development of the OJT capacity estimation methodology can reasonably be expected to significantly enhance Air Force training management capabilities.

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1.0 INTRODUCTION

A detailed analysis of the Air Force on-the-job training (OJT) system has explicitly recognized "...a need for better and more easily applied methods of monitoring and evaluating the Air Force OJT program in terms of costs, quality and effectiveness of training provided...."[1] Moreover, the Air Force Inspector General, in a recently completed Functional Management Inspection of the Air Force OJT program, has concluded that lack of cost and capacity information is a major hindrance to the efficient management of the program. Yet, estimation of the capacity of Air Force operational units to conduct OJT has received little attention prior to this report. Therefore, the fundamental objective of this study is to develop and demonstrate a practical methodology by which the capacity of Air Force units to perform OJT can be estimated.

Mounting pressures to obtain the most cost-effective mix of resident school training and OJT make it increasingly important for the Air Force to be able to determine the OJT capacities of its operational units. At its present level of operation, OJT may be less costly or otherwise more efficient than resident school training for some AFSC (Air Force Specialty Code) skill categories in some types of Air Force units. Yet, it would be unreasonable to replace all resident school training with OJT in such situations if doing so would cause the unit's OJT load to exceed capacity. At the extreme, excessive OJT might degrade primary mission performance below acceptable standards. More typically, as training loads increase, OJT costs are likely to rise until the cost-effectiveness of OJT relative to resident school training has been eliminated.

Clearly, Air Force decision-making concerning all of these issues would be enhanced by a workable methodology to estimate the capacity of operational units to conduct OJT. This report presents the results of an initial effort to develop and demonstrate such a methodology.

Thus, Section 2.0 provides background material concerning the nature of OJT and summarizes pertinent elements of the OJT literature. A conceptual model for determining OJT capacity is then developed in Section 3.0. Next, Section 4.0 describes the selection of operational units as bases for empirically testing the model and discusses the data sources utilized for these empirical tests. The results of estimating the structural equations of the conceptual model of OJT capacity

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[1] Stephenson, R. W., and J. R. Burkett, On-the-Job Training in the Air Force: A Systems Analysis, AFHRL-TR-75-83, AD-A036 206, Lowry AFB, Colorado, Air Force Human Resources Laboratory, Technical Training Division, December 1975, p. 9.

for the selected operational units are reported in Section 5.0. Finally, Section 6.0 summarizes the conclusions derived in the study and presents specific recommendations for further development and implementation of the OJT capacity estimation methodology.

The conceptual model of OJT capacity developed in this study is a conçice description of the complex interrelationships among the level of mission performance, the quality of mission performance, the amount of training provided, and the quality of training achieved by an Air Force operational unit. Thus, the model incorporates representations of the interdependence among these four attributes, the resources available to the unit, and pertinent external factors. The maximum capacity of a unit to conduct OJT is then determined as the maximum amount of training sustainable by the unit without compromising established standards for the level of mission performance, the quality of mission performance, and the quality of training. Similarly, the desirable OJT capacity of a unit is calculated as the maximum amount of training that the unit can conduct while maintaining a desirable balance among the level and quality of mission performance and training.

The model has been empirically tested by applying multiple linear regression analysis to estimate the basic structural equations of the model, to the extent possible, using existing data for six Air Force operational units. The operational units examined include four aircraft maintenance units responsible for servicing aircraft assigned to primary tactical flying missions, one transportation squadron responsible primarily for vehicle maintenance, and one supply squadron. In all cases, the data used in the analyses consist of measures routinely developed and maintained for the units by various Air Force offices.

Despite the substantial limitations in the availability of suitable data, the empirical analyses have revealed a persistent and strong inverse relationship between the amount of training conducted by a unit and the quality of mission performance attributable to the unit for all operational units studied. In addition, a perceptible, but weaker, correlation between the resources available to a unit and the quality of the unit's mission performance has also been detected. Finally, the possibility that an association exists among the quality of training provided in a unit, the training load of the unit, and conceivably, the resources available to the unit is also suggested by the empirical results. However, at least in the relatively low stress, peacetime situations examined in the study, no consistent interdependence is discernible among the level of mission performance achieved by a unit, the amount of training conducted by the unit, and the availability of resources to the unit.

The derivation of numerous statistically significant relationships, in spite of the relatively poor quality of the data obtainable from secondary sources and the absence of any indicators of some important

explanatory variables in those sources, is very encouraging. This favorable result suggests that further development of the conceptual model of OJT capacity formulated and preliminarily tested in this study can reasonably be expected to produce very useful methodologies for estimating OJT capacity.

Specifically, the derivation of an implementable OJT capacity estimation methodology will require expanded exploratory research, supported by a methodical program of data acquisition and retention designed to provide a comprehensive set of indicators describing all of the variables contained in the conceptual model. Thus, data pertinent to the construction of indicators of each variable in the conceptual model, possibly compiled at the level of individual work centers, should be collected and maintained for a representative sample of Air Force operational units. Empirical estimates of the coefficients of the model's basic structural equations should then be derived for each unit in the sample using these data. Next, the empirical results obtained for presumably similar units should be systematically compared and, to the extent possible, reconciled. Quantitative assessments of the OJT capacities of the units should then be produced on the basis of the reconciled coefficient estimates using the procedures formulated, but not applied, in this study. Finally, aggregation procedures should be developed, and empirically tested, to permit the calculation of OJT capacities for higher organizational levels than squadrons or flying wings.

Detailed discussions of the conceptual model, the data bases, the analytic results, and the recommendations for further development are presented in the remainder of this report.

2.0 BACKGROUND

2.1 The Nature of On-the-Job Training

Perhaps the most important reason why no technique has yet been developed to estimate OJT capacity lies in the sheer size and diversity of Air Force OJT. It has been estimated that, at any given time, approximately 10 percent of the authorized enlisted strength of the Air Force is engaged in the program in some capacity.[1] Virtually all enlisted personnel are trained on the job to some extent. In addition, most personnel who attain at least the 5-skill level conduct OJT from time to time. Consequently, the OJT program embraces all the variations of the Air Force skill spectrum, and embodies all the peculiarities of individual trainers and trainees.

This structural complexity is further confounded by the absence of a definition of OJT that is uniformly accepted throughout the Air Force. Air Force <u>Management Engineering Policies and Procedures</u> describes OJT as:

> ...a productive indirect category to accommodate time expended by a worker in a directly supervised, on-the-job proficiency training status, where the worker is being advised and/or assisted by the supervisor, but is not achieving any production. If a worker is "learning while producing," his time is recorded in the appropriate productive category, whether it be direct or indirect, and not as OJT.[2]

In contrast, AFM 50-23 states that:

> On-the-job training is an all-inclusive term which describes any and all training received by an airman while he is performing in a duty assignment of his AFS [Air Force Specialty].[3]

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[1] Stephenson, R. W., and J. R. Burkett, <u>On-the-Job Training in the Air Force: A Systems Analysis</u>, AFHRL-TR-75-83, AD-A036 206, Lowry AFB, Colorado, Air Force Human Resources Laboratory, Technical Training Division, December 1975, p. 9.

[2] Department of the Air Force, <u>Management Engineering Policies and Procedures</u>, AFM 25-5, Washington, D.C., August 8, 1973, plus changes, p. 4-12.

[3] Department of the Air Force, <u>On-the-Job Training</u>, AFM 50-23, Washington, D.C., August 15, 1974, p. 1-1.

This ambiguity about the nature of OJT is reflected in the established procedures for the maintenance of personnel records. Upgrade training (UGT) is accorded formal OJT status. Personnel are explicitly enrolled in UGT; and training records are maintained throughout their enrollment. Conversely, qualification training seldom is formally recognized while it is being performed. Rather, such training typically is recorded in a trainee's Job Proficiency Guide (JPG) only after it has been completed.

Yet, in the context of an initial research effort to develop a methodology for estimating the capacity of operational units to perform OJT, these distinctions among the various types of training conducted by operational Air Force units are of minor importance. All such training imposes similar demands upon unit resources.

- Qualified instructors and appropriate equipment must be provided for "hands-on" proficiency training.
- On occasion, equipment essential to primary mission performance must be released for use in training.
- Work schedules must be arranged to bring trainees, experienced personnel, and suitable equipment together.
- For certain specialized skills, funds must be budgeted for trainees' participation in field training detachment (FTD) programs.

Thus, regardless of the precise form of training provided, the capacity of an operational unit to perform OJT is directly dependent upon the availability of training opportunities. Moreover, these training opportunities, in turn, will depend on the availability of unit resources in excess of those required for primary mission performance.

Consequently, the provision of OJT and primary mission performance will typically be interdependent, largely through their competition for available resources. In addition, this interdependence generally will involve more than just an interaction between the level of mission performance achieved and the amount of OJT conducted. Rather, both the quality of mission performance attained and the quality of training provided usually will also be affected. Thus, inherent in the nature of OJT is a complex interrelationship among the amount of training performed, the quality of training provided, the level of mission performance achieved, and the quality of mission performance attained; and the development of a methodology to estimate OJT capacity unavoidably involves analysis of this interrelationship.

2.2 Review of Pertinent Literature

No previous study has directly examined the concept of the capacity of operational units to perform OJT. Numerous studies of other aspects of OJT have been conducted, however. Many of these studies provide useful insights into the measurement of OJT capacity.

The studies pertinent to the estimation of OJT capacity all address various elements of the cost-effectiveness of OJT programs. Thus, all of the pertinent studies can be related in some way to the basic concept that the cost-effectiveness of an OJT program can be evaluated by comparing the value added to the skills of the program's trainees with the costs of the resources used in the program.

Most of these studies have, either explicitly or implicitly, used increases in trainee productivity as a measure of the value added by OJT, and have employed decreases in trainer productivity as a component of training costs. These valuation techniques have been applied most directly by Gay[4] and by Gay and Nelson[5] who have estimated the net value added by OJT as the present value of the differences over time between the actual productivity of trainees in the specialties in which they have been trained and the productivity of these trainees in their highest valued alternative military assignment.

Productivity differences have been used somewhat less directly by Weiher and Horowitz[6] and by O'Neill[7] to measure OJT costs. Weiher and Horowitz include as an element of their cost estimates the value of foregone trainee output, which they measure as the difference over time between the trainees' wages and the value of their direct output. Similarly, O'Neill measures OJT costs in terms of the productivity foregone by replacing a journeyman with a trainee.

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[4] Gay, R. M., Estimating the Cost of On-the-Job Training in Military Occupations: A Methodology and Pilot Study, R-1351-ARPA, Santa Monica, California, The RAND Corporation, April 1974.

[5] Gay, R. M., and G. R. Nelson, Cost and Efficiency in Military Specialty Training, Santa Monica, California, The RAND Corporation, January 1974.

[6] Weiher, R., and S. A. Horowitz, Formal and On-the-Job Training for Navy Enlisted Occupations, Professional Paper No. 83, Arlington, Virginia, Center for Naval Analyses, November 1971.

[7] O'Neill, D. M., "Determinants of Labor Turnover Costs in the Military," Study 4, Part 1, Volume I of Studies Prepared for the President's Commission on an All-Volunteer Armed Force, Washington, D.C., U. S. Government Printing Office, November 1970.

Finally, Arzigian[8] strongly implies the use of productivity changes as a measure of the value added by OJT when he incorporates in his estimates of OJT costs the assumption that a trainee's effectiveness increases linearly over time from the conclusion of basic training through completion of OJT and attainment of the journeyman level. Thus, in combination, all of the studies discussed above clearly indicate both a direct relationship between the current provision of OJT and future mission performance, and an inverse correlation between current OJT activities and current mission performance. These research results strongly support the conclusion reached in the preceding section that developing a methodology to estimate OJT capacity will necessarily involve examination of the complex interrelationships between mission performance and the provision of OJT.

Further evidence of the competitive relationship between current OJT efforts and current mission performance is provided by several studies that estimate the cost of OJT in terms of the value of the resources devoted to the provision of OJT. These studies, including research conducted by Dunham[9] and by Eisele, Bell and Laidlaw,[10] as well as the previously cited work by Arzigian[8] and by Weiher and Horowitz,[6] all identify the value of trainers' and supervisors' time devoted to OJT as key components of OJT cost. In the absence of corresponding increases in overtime, allocation of these resources to OJT will necessarily reduce the amount of experienced personnel effort available for primary mission performance. Thus, at the extreme, the excessive allocation of skilled personnel resources to conduct OJT can cause mission performance to decline below acceptable standards and thereby cause OJT capacity to be exceeded.

Finally, a study by Lecznar[11] has examined the relative effectiveness of OJT and formal resident school training in terms of six criteria related to the primary mission performance of graduates of the two types

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[8] Arzigian, S., On-the-Job Training Costs: An Analysis, U. S. Navy, Bureau of Naval Personnel, WRM 67-52, Washington, D.C., June 1967.

[9] Dunham, A. D., Estimated Cost of On-the-Job Training to the 3-Skill Level in the Communications Center Operations Specialty, AFHRL-TR-72-56, AD-753 093, Lackland AFB, Texas, Air Force Human Resources Laboratory, Personnel Research Division, June 1972.

[10] Eisele, C. R., T. R. Bell, and C. D. Laidlaw, Cost Analysis of Air Force On-the-Job Training: Development and Demonstration of a Methodology, AFHRL-TR-78-88, Lowry AFB, Colorado, Air Force Human Resources Laboratory, Technical Training Division, May 1979.

[11] Lecznar, W. B., The Road to Work: Technical School Training or Directed Duty Assignment, AFHRL-TR-72-29, AD-754 845, Lackland AFB, Texas, Air Force Human Resources Laboratory, Personnel Research Division, April 1972.

of training. Specifically, the mission performance of technical school and OJT graduates are compared in terms of job difficulty, average task difficulty, number of tasks performed, job interest, utilization of talent and training, and overall job performance. This study, which reveals no significant differences between OJT and formal resident school training, suggests that measures of post-training performance represent potentially useful indicators of training quality. This insight has direct relevance to the formulation of quantitative indicators of training quality for use in empirically investigating the estimation of OJT capacity.

3.0 CONCEPTUAL MODEL OF OJT CAPACITY

Based on the review of available literature and the initial explorations into the nature of OJT, four key concepts have been identified as the basic elements of a conceptual model of OJT capacity. These concepts are

- The level of mission performance.
- The quality of mission performance.
- The quality of training provided.
- The amount of training provided.

The predominant concern of any Air Force operational unit is the successful performance of its primary mission. Accordingly, any degradation in the level or quality of mission performance below acceptable standards cannot be tolerated. Training loads causing such degradation would be considered to exceed capacity.

Similarly, the amount of training provided is meaningless if its quality is inadequate. Therefore, levels of training that cause training quality to deteriorate below some minimum standard would also be considered to exceed capacity.

These basic relationships are depicted graphically in Figure 1. C1, C2, and C3 represent the maximum amounts of training sustainable without compromising the established standards for the level of mission performance, the quality of mission performance, and the quality of training, respectively. Thus, the OJT capacity indicated in this figure is C2. This amount of training is the maximum training load for which the level of mission performance, the quality of mission performance, and the quality of training all fulfill their minimum standards. Any greater amount of training would cause the quality of mission performance to decline to an unacceptable level.

This representation considerably oversimplifies the determination of OJT capacity, however. The level of mission performance, the quality of mission performance, and the quality of training are unlikely to be independent. Rather, training quality and mission performance quality both can reasonably be expected to decline as the level of mission performance increases, at least at higher mission performance levels. Moreover, training quality and mission performance quality are also likely to be interrelated, although the nature of the correlation is more complex. Current mission performance quality should be positively influenced by the quality of previous training insofar as training improves productivity. Conversely, current training quality and current mission performance quality may be negatively related, since

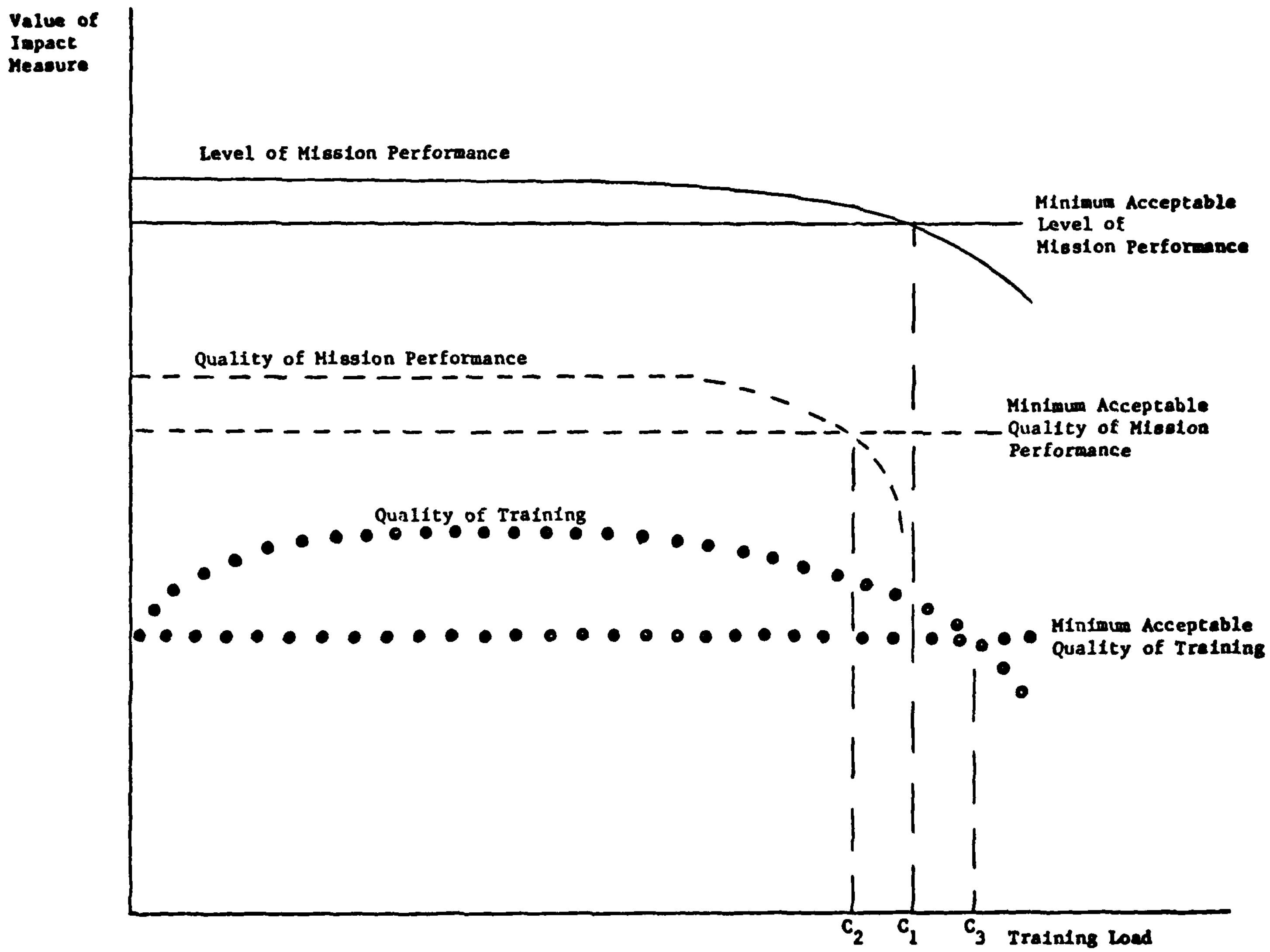

FIGURE 1: Conceptual Model of OJT Capacity

their provision draws upon a common pool of resources. For example, skilled personnel performing training duty might improve training quality; while their absence from directly productive activities might reduce the quality of mission performance.

In addition, other factors, such as resource availability, job characteristics, organizational considerations, and external influences can also affect the level and quality of both mission performance and training. A more detailed list of such factors is presented in Table 1.

All of the propositions discussed should be incorporated in any comprehensive, operational model of OJT capacity. These propositions, and their interrelationships, can be conveniently summarized mathematically in terms of the following system of equations:

$$ML = f(TL, TQ_p, R, E) \quad (1)$$

$$MQ = g(ML, TL, TQ, TQ_p, R, E) \quad (2)$$

$$TQ = h(ML, TL, R, E) \quad (3)$$

where ML = the level of mission performance.

MQ = the quality of mission performance.

TL = the amount of training provided (the training load whose maximum attainable value defines the OJT capacity of the operational unit).

TQ = the quality of current training.

TQ_p = the quality of previous training.

R = the resources available to the operational unit.

E = external, and other, factors.

The analysis presented previously in this section has examined in considerable detail the anticipated nature of the interrelationships among the variables in these equations. These anticipated interrelationships can be restated conveniently in terms of the expected signs of the first-order partial derivatives of the equations. Specifically, the anticipated signs of those partial derivatives for which unequivocal expectations can be formed are

- For equation (1), $\partial ML/\partial TL < 0$, $\partial ML/\partial TQ_p > 0$, and $\partial ML/\partial R > 0$.
- For equation (2), $\partial MQ/\partial ML < 0$, $\partial MQ/\partial TL < 0$, $\partial MQ/\partial TQ < 0$, $\partial MQ/\partial TQ_p > 0$, and $\partial MQ/\partial R > 0$.
- For equation (3), $\partial TQ/\partial ML < 0$, $\partial TQ/\partial TL < 0$, and $\partial TQ/\partial R > 0$.

TABLE 1: Factors Influencing OJT Capacity

- Resource availability
  - Availability of needed quantity and quality of training facilities and equipment.
  - Presence of professional training personnel.
  - Presence of qualified instructors.
  - Availability of instructor time in excess of that required for non-training responsibilities, including the primary mission, record keeping, and administration.
  - Influence of work shift scheduling and shop manning on the presence of skilled personnel needed for proficiency training within a work center.
  - Budgetary constraints on participation in field training detachment (FTD) programs.
- Job characteristics
  - Difficulty of tasks to be trained.
  - Frequency of occurrence of tasks requiring proficiency training.
- Organizational considerations
  - Command emphasis on the importance of training.
  - Morale.
  - Trainee characteristics, such as ability, knowledge, and motivation.
- External influences
  - Seasonality.
  - Weather conditions, such as temperature and snow.

Finally, applying standards -- determined by Air Force policy -- specifying the minimum acceptable values of the level of mission performance (ML^0), the quality of mission performance (MQ^0), and the quality of training (TQ^0), the OJT capacity of the unit can be calculated as the maximum training load supportable by the unit. This calculation is depicted graphically in Figure 1. Mathematically, it can be expressed as

$$\begin{aligned} &\text{Maximize } TL \\ &\text{subject to } ML \geq ML^0 \\ &\qquad\qquad\quad MQ \geq MQ^0 \\ &\text{and} \qquad\quad\; TQ \geq TQ^0 \end{aligned}$$

Similarly, if Air Force policy-makers can develop a functional relationship indicating the relative desirability of different combinations of mission performance level, mission performance quality, training load, and training quality, the desirable OJT capacity of the unit can also be estimated. This estimation can be denoted mathematically as

$$\begin{aligned} &\underset{TL}{\text{Maximize}}\; D\,(ML, MQ, TL, TQ) \\ &\text{subject to } ML \geq ML^0 \\ &\qquad\qquad\quad MQ \geq MQ^0 \\ &\text{and} \qquad\quad\; TQ \geq TQ^0, \end{aligned}$$

where $D\,(ML, MQ, TL, TQ)$ is the unit's "desirability" function.

Since, other things being equal, the unit prefers higher levels of each of the "desirability" function's independent variables to lower levels of the same variable, each of the function's first-order partial derivatives can reasonably be expected to be positive.

The solution of this problem will indicate the optimal mission performance level, mission performance quality, training load, and training quality that can be achieved by the unit -- relative to its own criterion of desirability -- while maintaining acceptable values of mission performance level, mission performance quality, and training quality. It is conceivable that, in many situations, the minimum acceptability conditions will not impose binding constraints on the solution. Nevertheless, they must be included in the formulation of the problem to preclude any unacceptable degradations of the corresponding variables of primary interest.

4.0 FRAMEWORK FOR MODEL DEMONSTRATION

To provide a basis for empirically testing the conceptual model of OJT capacity formulated in the preceding section, two preparatory tasks have been performed:

- Selection of the specific Air Force operational units for which the application of the model has been demonstrated.

- Identification of adequate sources of the various types of data required for application of the model for each selected unit.

The outcomes of these two tasks are discussed in the following two subsections.

4.1 Selection of Operational Units

To assure a reasonably thorough assessment of the potential range of application of the OJT capacity estimation methodology, empirical tests of the conceptual model of OJT capacity have been conducted for two different broad classes of Air Force operational units:

- Units performing maintenance on aircraft assigned to primary flying missions.

- Units performing no aircraft maintenance activities.

This grouping has been established in recognition of the clear distinction between the direct association of aircraft maintenance activities with the level and quality of primary mission performance, and the much more indirect relationships of primary mission performance with most other types of activity. This distinction has clear practical significance for this study. Specifically, in aircraft maintenance units, OJT efforts can reasonably be expected to be directly relatable to measures of primary mission performance. Conversely, for other units, OJT activities are likely, at best, to be relatable to instrumental indicators of unit performance that are believed to have some indirect ultimate influence on primary mission performance. Consequently, to investigate the potential range of application of the OJT capacity estimation methodology, empirical tests of the methodology must be conducted for both of these broad classes of Air Force operational units.

A total of six operational units have been examined in this study. Four are aircraft maintenance units, three attached to wings equipped with F-4 aircraft and one attached to a wing with RF-4 aircraft.[12] The fifth unit is a transportation squadron, responsible primarily for vehicle maintenance. The sixth is a supply squadron.

4.2 Data Sources

To perform a comprehensive empirical demonstration of the OJT capacity estimation methodology, six categories of data must be obtained. These categories consist of indicators of

- The level of mission performance.
- The quality of mission performance.
- The amount of training provided.
- The quality of training.
- The availability of resources.
- External and other factors.

For the current study, no time or resources have been allocated for primary data collection efforts. Consequently, all data used in the empirical analyses have been obtained from existing secondary sources.

Ideally, the data should describe activities and resources at the level of individual work centers. It is at this level that the interactions among resources, training loads, and mission performance that, in combination, determine OJT capacity can reasonably be expected to occur most strongly and directly.

Unfortunately, none of the operational units examined in the study routinely develop and maintain the desired types of data at the work center level. Although it is relatively simple to obtain suitable

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[12] Part of the reason for examining these four units has been to compare the relationships between training loads and mission performance for two different types of aircraft maintenance organization: Production Oriented Maintenance Organization (POMO) and traditional organization. The results of this comparison are reported in P. J. DeLeo and T. R. Bell, Estimating the Capacity of Air Force Maintenance Organizations to Conduct On-the-Job Training, Lowry AFB, Colorado, Air Force Human Resources Laboratory, Technical Training Division, December 1979.

information about the current characteristics of any work center, it is virtually impossible to obtain this information for enough historical time periods to permit empirical demonstration of the model.

For example, in the aircraft maintenance units, the Maintenance Management Information Control System (MMICS) appears to be an ideal source of information. Among its many capabilities, MMICS contains data concerning "...required training courses, inspection and special qualifications, OJT training information, training statuses, due and completed dates, and an individual's complete training history."[13] Moreover, this information is recorded for virtually all training activities pertinent to OJT, including "...proficiency, qualification, certification, resident/FTD, dual channel OJT and locally established requirements."[13] However, MMICS does not systematically retain data describing a unit's historical training activities. Whenever airmen are transferred to other units, all of their records are deleted from the data stored in MMICS for the units from which they are departing. Moreover, printed copies of MMICS data are retained as a safeguard against inadvertent information losses for at most 3 months. Consequently, MMICS cannot provide a sufficiently long sequence of historical training and mission performance information to permit its use as a data source in this study.

As a direct result of such data limitations, it has been impossible to perform any empirical demonstrations of the OJT capacity estimation methodology at the work center level. Rather, the methodology has been applied at the squadron level for the transportation and supply units, and at the wing level for the aircraft maintenance units. Only at these higher organizational levels could a sufficient amount of existing historical data be obtained to permit empirical analysis.

For the aircraft maintenance units, the data used to demonstrate the OJT capacity estimation methodology have been assembled from six different sources. Most of these information sources are printed summaries published by various wing-level analysis and evaluation offices.

> Monthly Maintenance Summary, Part I, prepared by the wing maintenance analysis office, provides numerous monthly indicators of wing mission performance. Historical records of the indicators are reported in each summary for as many as 12 consecutive months. Moreover, because this information is submitted to the analysis staff at MAJCOM (Major Command) headquarters, all wings employ the same format in this document.

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[13] Department of the Air Force, Maintenance Management Information Control System (MMICS), Volume I, AFM 66-278 (C12), Washington, D.C., November 1977, p. 10-1.

- Monthly Maintenance Summary, Part IV,[14] also compiled by the maintenance analysis office, contains a summary of quality control evaluations. Two types of evaluations are reported: personnel evaluations appraising the adequacy of task performance as determined by directly observing qualified airmen performing the task, and task evaluations assessing the completeness and correctness of task performance after its execution. To the extent that maintenance task performance contributes to primary mission performance, these evaluations can be used as indicators of the quality of mission performance. Alternatively, to the extent that successful on-the-job task performance indicates adequacy of training, the evaluations can be interpreted as measures of training quality. In either event, this information represents potentially pertinent data for the study.

- Records maintained by the training management office specify the amount of formally monitored training conducted in the aircraft maintenance units. In particular, these records report UGT enrollments and completions. However, the training management offices of different bases employ different procedures concerning the retention of historical information.

- The Daedalian Monthly Maintenance Award Report, which also publishes monthly UGT enrollment, can, fortunately, normally be used to supplement the other training records to obtain an uninterrupted historical sequence for UGT enrollment. This report also contains information about a variety of other aircraft maintenance activities and, hence, can often provide values found to be missing in other data sources.

- The Organizational Manning Report, prepared by the programs and mobility office, provides an exact record of actual personnel assignments in individual work centers. This report identifies the work center, duty assignment, and Primary Air Force Specialty Code (PAFSC) for each airman assigned to the unit; and it indicates the authorized manning levels for each work center.

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[14] Monthly Maintenance Summary, Parts II and III, contain more detailed information about the maintenance of individual aircraft and specific component systems. Thus, these reports directly reflect the performance of individual work centers. However, as explained previously, the absence of comparable data about training activities precludes the use of this information.

- Records maintained by the Wing Historian can occasionally be used to provide information missing from other data sources. However, most of the information compiled by this office pertains to the entire wing, but does not describe individual squadrons or work centers.

Obviously, many of these data sources just described contain information that overlaps data in other sources. A complete compilation of the potentially pertinent indicators reported in each cited data source is presented in Table 2. Nevertheless, undesirable missing information remains for many important variables and reduces the usable size of the final data base. For some indicators, 50 consecutive monthly observations are available; while for other variables, only four observations have been obtained.

For the transportation and supply squadrons, fewer sources of pertinent information have been found. Nevertheless, the identified sources have provided uninterrupted historical data series for all variables of interest spanning 24 consecutive months.

- For the transportation squadron, the VIMS (Vehicle Integrated Management System) Monthly Analysis, prepared by the maintenance analysis branch of the squadron, furnishes several monthly measures of the performance of the squadron's vehicle maintenance mission. Additional unpublished vehicle maintenance performance indicators are also prepared by and available from the squadron's maintenance analysis branch.

- For the supply squadron, internal reports compiled by its analysis office provide many monthly indicators of the level and quality of the squadron's logistic efforts. For each of the squadrons, historical values of the indicators are presented in each report for as many as 12 consecutive months.

- Records of the amount of formally monitored training conducted in the two squadrons are maintained by the OJT office of the Consolidated Base Personnel Office. These records indicate, for each squadron, the total monthly training loads and upgrades for each skill level, and the overall amounts of UGT and retraining conducted in each month.

- Additional records compiled by the OJT office specify the actual number of personnel assigned to each squadron in each month. The number of personnel authorized for each squadron throughout each quarter is also available through the Consolidated Base Personnel Office.

TABLE 2: Aircraft Maintenance Unit Data Sources

Data Item \ Data Source (Document and/or Office)	Monthly Maintenance Summary, Part I	Monthly Maintenance Summary, Part IV	Daedalian Maintenance Award Report	Wing Historian	Training Management	Organizational Manning Report - Programs and Mobility
Home Flown Hours	X		X	X		
Home Sorties Scheduled	X		X			
Home Sorties Flown	X		X	X		
Home Sorties Flown as Scheduled	X					
Ground Aborts	X		X			
Air Aborts	X		X			
Maintenance Cancellations	X					
Maintenance Attrition Rate	X					
Maintenance Late Take-Offs	X					
Broke Aircraft	X					
Aircraft Recovered Within 3 Hours	X					
Aircraft Recovered Within 6 Hours	X					
Maintenance Scheduling Effectiveness	X			X		
Possessed Hours	X					
NMCM(S)[a] Hours	X					
NMCM(U)[b] Hours	X					
PMCM[c] Hours	X					
Percent NMCM[d]	X		X			
Percent PMCM[c]	X		X			
QVIs[e] Satisfactory and Unsatisfactory		X	X			
PEs[f] Passed and Failed		X				
Detected Safety Violations		X				
Discrepancies Count						
Repeats						
Recurs						
Cannot Duplicates						
Base Repair Rate						
Mission Capability				X		
OJT Upgrade Trainees: 5 and 7 Level			X		X	
Manhours Assigned						
Overtime Manhours						
Training Manhours						
Assignments by Duty Skill Level			X			X
Authorizations by Duty Skill Level			X			X
Assignments Whose Duty AFS[g] Differs From Their Primary AFS[g]						X
FTD Enrollments					X	
Number of Ancillary Training Events					X	
Number of Assignments Having PAFSC[h] 75XXX					X	X

[a] Not mission capable due to scheduled maintenance.
[b] Not mission capable due to unscheduled maintenance.
[c] Partially mission capable, but requiring maintenance.
[d] Not mission capable due to maintenance.
[e] Quality verification inspections.
[f] Personnel evaluations.
[g] Air Force specialty.
[h] Primary Air Force specialty code.

- Data concerning monthly weather conditions have been obtained from the base weather station. These data describe the typical base weather situation in terms of monthly maximum, minimum, and average temperature, snowfall, and precipitation levels.

Complete compilations of the potentially pertinent indicators available from each cited data source are presented for the transportation and supply squadrons in Tables 3 and 4, respectively.

TABLE 3: Transportation Squadron Data Sources

Data Item \ Data Sources (Document and/or Office)	VIMS Monthly Analysis	Maintenance Analysis Branch, Transportation Squadron	OJT Office, Consolidated Base Personnel Office	Consolidated Base Personnel Office	Base Weather Station
VDM[a] hours	X				
Estimated direct labor hours required		X			
Actual direct labor hours applied	X				
UGT enrollment			X		
OJT upgrades to 3, 5, and 7 levels			X		
Personnel assigned			X		
Personnel authorized				X	
Assigned personnel fully trained for grade			X		
Average monthly temperature					X
Average monthly snowfall					X
Average monthly precipitation					X

[a]Vehicle down for maintenance.

TABLE 4: Supply Squadron Data Sources

Data Item \ Data Sources (Document and/or Office)	Analysis Office, Supply Squadron	OJT Office, Consolidated Base Personnel Office	Consolidated Base Personnel Office	Base Weather Station
Reverse post rate	X			
Inventory adjustments	X			
RCA[a] units over and short	X			
Backorders	X			
EOQ[b] units over and short	X			
Total auditable documents	X			
Line items issued	X			
Line items issued and backordered	X			
RCA[a] units	X			
Total transactions	X			
UGT enrollment		X		
OJT upgrades to 3, 5, and 7 levels		X		
Personnel assigned		X		
Personnel authorized			X	
Assigned personnel fully trained for grade		X		
Average monthly temperature				X
Average monthly snowfall				X
Average monthly precipitation				X

[a]Repair cycle assets.
[b]Economic order quantity.

5.0 EMPIRICAL RESULTS

Despite the limited availability of suitable data from existing sources, a persistent and strong relationship between mission performance and training load has been estimated for all operational units studied. The derivation of statistically significant *relationships* in spite of the relatively poor quality of the obtainable indicators and the absence of some important explanatory variables is most encouraging. This favorable result suggests that further study can reasonably be expected to produce very useful methodologies for estimating OJT capacity.

The data limitations encountered in the study have caused four basic problems in empirically demonstrating the application of the methodology:

- The available indicators of mission performance seldom are unambiguous measures of either the level or the quality of performance. Consequently, the empirical results derived for these indicators are often amenable to varying and inconclusive interpretations.

- Satisfactory indicators of the quality of training are generally unavailable. Hence, no relationships responsive to the quality of training have been derived.

- The existing indicators of training load essentially measure only gross UGT activity. No measures of other types of training, or of trainees' progress within UGT, are available.

- Indicators of other resources and external effects are restricted to measures of enlisted personnel strength and weather conditions.

If more directly applicable data were made available -- by retaining data now routinely discarded or by systematically collecting new data -- these difficulties would be sharply reduced.

Nevertheless, the empirical results collectively demonstrate a convincing relationship between the mission performance and training loads of Air Force operational units. These results, developed by applying multiple linear regression analysis to the conceptual model of OJT capacity formulated in Section 3.0, are presented in the remainder of this section.

The results for the three different types of operational units appear in the order of increasing complexity. This order of presentation will permit the reader to comprehend the less complex results fully before being confronted with the results that are more difficult to interpret.

Thus, the results derived for the transportation squadron appear in Section 5.1; the results for the supply squadron are reported in the following section; and the results for the aircraft maintenance units are summarized in Section 5.3. The transportation squadron offers only one good measure of mission performance, and the available data for the explanatory variables are limited also. The supply squadron provides two indicators of mission performance. However, these measures are not very well defined and, hence, present problems in interpretation of the empirical results. Finally, the aircraft maintenance units furnish the largest amounts of data, but also entail the greatest difficulties in interpretation.

5.1 Transportation Squadron

Due to data limitations, the only equation from the conceptual model of OJT capacity that has been estimated for the transportation squadron is the equation describing the quality of mission performance

$$MQ = g\ (ML, TL, TQ, TQ_p, R, E)$$

where, as before,

MQ = the quality of mission performance.

ML = the level of mission performance.

TL = the amount of training provided.

TQ = the quality of current training.

TQ_p = the quality of previous training.

R = the resources available to the squadron.

E = external, and other, factors.

In addition, because no suitable data have been found measuring either the level of mission performance or the quality of training achieved in the squadron, the relationship actually examined has been

$$MQ = G\ (TL, R, E)$$

Four different formulations of this basic relationship in which mission performance quality is associated with training load, resource availability, and external factors have been estimated for the transportation squadron.

Only one acceptable indicator of the dependent variable, the quality of mission performance, has been uncovered for this squadron. This indicator is the total number of hours that vehicles have been down for maintenance by the transportation squadron during each month (VDMHRS). It represents a conceptually satisfactory measure of the quality of mission performance since, other things being equal, the greater are the number of hours that vehicles have been done for maintenance by the squadron, the less productive the squadron's maintenance efforts must have been. Unfortunately, other things are rarely equal. The number of miles that vehicles are driven, the rate at which vehicles arrive for maintenance, and the difficulty of the maintenance required by the newly arrived vehicles all vary from month to month. Consequently, VDMHRS unavoidably reflects these, and other, aspects of changes in the workload confronting the squadron. Moreover, since no data have been found describing any such external factors, it is impossible to adjust for these effects empirically. Rather, the possible influence of any excluded explanatory variables should be taken into consideration when interpreting the empirical results.

The explanatory variables entered into the estimated relationships include indicators of the amount of training provided (TL), squadron resources (R), and some external factors (E).

The basic variable used as an indicator of the amount of training provided in the squadron is number of enlisted personnel enrolled in UGT in each month (TLOAD). This variable captures most of the squadron's training load. However, it does not reflect informal OJT activities such as qualification training, nor does it account for any progress achieved by trainees as their OJT proceeds. In two of the relationships estimated for this squadron, TLOAD is entered directly as an explanatory variable. In the remaining two formulations, TLOAD has been divided by the number of enlisted personnel assigned to the squadron to produce a new explanatory variable, the proportion of the squadron's enlisted personnel enrolled in UGT in each month (RELTLD).

Only one basic variable has been found to measure the resources available to the squadron. This variable specifies the number of enlisted personnel assigned to the squadron in each month. As indicated previously, it has been used as the denominator of the explanatory variable RELTLD in two of the estimated relationships. Moreover, in one other formulation, it has been divided by the number of enlisted personnel authorized for the squadron in each month to create an additional explanatory variable, the proportion of the squadron's authorized enlisted strength actually assigned to the squadron in each month (RELSTR).

Finally, two somewhat crude measures of monthly weather conditions have been included as indicators of external factors. These variables are the average snowfall in each month (SNOW) and the deviation of the average temperature in each month from the average annual temperature at the Air Force base housing the squadron (DEVTMP).

Thus, assuming a basic linear relationship, the general form of the equation actually estimated for the transportation squadron is

$$MQ = a + b\,TL + c\,R + d\,E$$

where MQ = VDMHRS.

TL = TLOAD or RELTLD.

R = RELSTR.

E = SNOW and/or DEVTMP.

Table 5 presents the empirical results obtained by applying multiple linear regression analysis to derive estimates of four different formulations of this general equation. These represent all versions of the general equation for which all estimated coefficients are statistically significant at the 5 percent level. All attempts to establish versions of the equation containing the constant term, a, have produced statistically insignificant estimates of the constant. Consequently, none of the formulations reported in Table 5 contains a constant term.

Despite all of the inadequacies in the data, these results uniformly reveal a statistically significant positive relationship between the level of training provided in the transportation squadron and VDMHRS. Although the overall quality of the estimated relationships, as measured by R^2, is not exceptional, the generally high values of the t-statistics[15] associated with the training load variables clearly and strongly indicate that increases in the amount of training conducted in the transportation squadron are significantly correlated with reductions in the quality of the squadron's mission performance. In addition, the results suggest that RELTLD, the unit's training load relative to its assigned enlisted strength, provides a better description of this relationship than does TLOAD, the absolute amount of training conducted in the squadron.

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[15] Each t-statistic reported in Table 5 indicates the number of standard deviations by which the corresponding estimated regression coefficient differs from zero. The significance level associated with the t-statistic, therefore, specifies the probability that the estimated coefficient would have been derived empirically if the true value of the coefficient were zero.

TABLE 5: Empirical Results of Transportation Squadron Regressions

Regression Coefficients (and t-statistics)					R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
TL		R	E				
TLOAD	RELTLD	RELSTR	SNOW	DEVTMP			
301.3 (1.80)[a]		6,219.3 (1.73)[a]	1,230.2 (2.09)[a]	456.3 (3.02)[a]	0.331	0.164	1.86 (4,20)
492.7 (13.12)[a]			1,620.9 (3.29)[a]	565.0 (4.68)[a]	0.437	0.338	4.14 (3,20)[a]
	45,821.4 (12.63)[a]		1,564.7 (3.04)[a]	521.5 (4.08)[a]	0.316	0.196	2.47 (3,20)[b]
	55,294.9 (24.68)[a]			184.2 (2.41)[a]	0.257	0.174	2.94 (2,20)[b]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

5.2 Supply Squadron

As in the case of the transportation squadron, the lack of suitable data for the supply squadron permits the estimation of only one equation from the conceptual model of OJT capacity formulated in Section 3.0. Moreover, as before, the only relationship that can be empirically investigated is the equation describing the quality of mission performance

$$MQ = g\ (ML,\ TL,\ TQ,\ TQ_p,\ R,\ E).$$

However, for the supply squadron, no data have been located describing either the level of training quality achieved or any external factors likely to affect supply operations. Consequently, the relationship actually analyzed for this squadron has been

$$MQ = G\ (ML,\ TL,\ R).$$

Fifteen different formulations of this basic relationship, in which mission performance quality is associated with mission performance level, training load, and resource availability, have been estimated for the supply squadron.

Since no single definitive measure of the dependent variable, the quality of mission performance, has been uncovered, two different measures considered to be reasonable indicators of poor mission performance quality have been employed as dependent variables. The first variable measures adjustments in recorded inventory balances (INVADJ); while the second measures reverse postings (RPOST) -- computer entries that reverse previous erroneous entries. Both variables measure, basically, personnel errors. Hence, both should capture some aspects of the quality of mission performance. Yet, they reflect neither the activities of all personnel in the squadron, nor all facets of the overall performance of the unit.

Three fundamental types of explanatory variables enter into the estimated relationships, including indicators of the level of mission performance (ML), the amount of training provided (TL), and squadron resources (R).

Three different variables have been tested as indicators of the level of mission performance:

- ISSUED: the number of items issued by the squadron in each month.
- TRANS: the number of computer transactions processed by the squadron in each month.
- DCC: the number of auditable documents generated by the squadron in each month.

None of these variables represents an ideal measure of the level of mission performance, but each does capture some aspect of the amount of supply services provided.

Once again, the basic variable used to indicate the amount of training conducted in the squadron is the number of enlisted personnel enrolled in UGT in each month (TLOAD). In seven of the relationships estimated for this unit, TLOAD is entered directly as an explanatory variable. In seven others, TLOAD has been divided by the number of enlisted personnel assigned to the squadron to create a new explanatory variable, the proportion of the enlisted personnel enrolled in UGT each month (RELTLD). Finally, to examine the effect on mission performance quality of changes in the amount of training conducted over time, one relationship has been estimated using the difference between the squadron's training loads in consecutive months (DELTLD) as an explanatory variable.

Only one variable has been discovered to measure the resources available to the squadron. This variable specifies the number of enlisted personnel assigned to the unit and, as indicated previously, has been used as the denominator of the variable RELTLD in seven of the estimated relationships.

Therefore, assuming again a linear relationship, the general form of the equation actually estimated for the supply squadron is

$$MQ = a + b\,ML + c\,TL$$

where MQ = INVADJ or RPOST.

ML = ISSUED, TRANS, or DCC.

TL = TLOAD, RELTLD, or DELTLD.

Tables 6 and 7 present the empirical results obtained by applying multiple linear regression analysis to generate estimates of 15 different formulations of this general equation. These formulations include all versions of the general equation for which all estimated coefficients are statistically significant at the 5 percent level. In addition, to facilitate comparison of the results obtained for the two alternative indicators of the quality of mission performance, the tables present the estimates derived for each of these dependent variables using as explanatory variables all pairwise combinations of TLOAD or RELTLD with ISSUED, TRANS, or DCC. The results derived using INVADJ as the dependent variable appear in Table 6; while Table 7 displays the results obtained using RPOST as the dependent variable.

TABLE 6: Empirical Results of Supply Squadron Regressions with INVADJ as Dependent Variable

Regression Coefficients (and t-statistics)								
	TL		ML					
Constant	TLOAD	RELTLD	ISSUED	TRANS	DCC	R^2	$\bar{R}^2$	F-statistic (and degree of freedom)
-255.7	10.96 (2.14)[a]					0.203	0.114	4.57 (1,18)[a]
-85.4	11.34 (2.16)[a]		-0.187 (-0.61)			0.220	0.082	2.39 (2,17)
-170.7	11.24 (2.07)[a]			-0.0007 (-0.22)		0.205	0.065	2.19 (2,17)
-347.7	10.91 (2.07)[a]				0.0027 (0.19)	0.204	0.064	2.18 (2,17)
-303.8		4188.9 (2.20)[a]				0.212	0.124	4.84 (1,18)[a]
-130.5		4344.7 (2.23)[a]	-0.193 (-0.63)			0.230	0.094	2.54 (2,17)
-205.1		4323.7 (2.14)[a]		-0.0009 (-0.26)		0.215	0.077	2.33 (2,17)
-387.9		4170.5 (2.13)[a]			0.0025 (0.17)	0.213	0.075	2.30 (2,17)

[a]Significantly different from 0 at the 5 percent level.

TABLE 7: Empirical Results of Supply Squadron Regressions with RPOST as Dependent Variable

Regression Coefficient (and t-statistics)									
	TL			R					
Constant	TLOAD	RELTNG	DELTNG	ISSUED	TRANS	DCC	R^2	$\bar{R}^2$	F-statistic (and degree of freedom)
388.1	-2.46 (-1.38)[b]			0.219 (2.11)[a]			0.252	0.120	2.86 (2,17)[b]
148.1	-3.50 (-2.52)[a]				0.0038 (4.46)[a]		0.566	0.489	11.06 (2,17)[a]
45.8	-2.29 (-1.63)[b]					0.0159 (4.13)[a]	0.529	0.449	9.54 (2,17)[a]
386.4		-868.4 (-1.30)		0.219 (2.09)[a]			0.243	0.109	2.72 (2,17)[b]
151.2		-1281.5 (-2.44)[a]			0.0039 (4.43)[a]		0.558	0.480	10.73 (2,17)[a]
43.7		-809.4 (-1.53)[b]				0.0159 (4.10)[a]	0.521	0.437	9.25 (2,17)[a]
174.1			-12.31 (-3.56)[a]	0.265 (2.83)[a]			0.522	0.432	8.73 (2,16)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

The regression coefficients and t-statistics reported in Table 6 indicate that INVADJ is uniformly positively related to the amount of training provided in the unit, although the overall quality of the estimated relationships, as measured by R^2, is not exceptional. These empirical results also suggest that the incidence of personnel errors leading to inventory adjustments is not influenced significantly by the volume of work processed by the squadron.

Conversely, as revealed in Table 7, RPOST is consistently negatively related to all indicators of the level of training conducted by the squadron. Although this outcome is contrary to prior expectations, two possible explanations for this empirical result appear reasonable: either trainees perform relatively menial tasks, such as entering information into a computer, more carefully than do experienced personnel, or else trainees may be more closely supervised than are the fully trained airmen. The results presented in Table 7 also indicate that the incidence of personnel errors resulting in reverse postings is significantly positively related to the amount of work processed by the squadron. In fact, the t-statistics suggest that, in general, RPOST is more strongly influenced by workload considerations than by training load effects.

To provide some perspective to these apparently contradictory sets of empirical results, observe that, in contrast to RPOST, INVADJ reflects a much broader range of personnel errors, including errors associated with the more complex, less menial supply operations. Thus, INVADJ is a more comprehensive indicator of the quality of mission performance than is RPOST; and the results reported in Table 6 represent a more thorough and convincing test of the overall relationship between mission performance quality and squadron training loads than do the results derived using RPOST as the dependent variable.

5.3 Aircraft Maintenance Units

The four aircraft maintenance units have presented the greatest opportunity in this study for empirically testing all components of the conceptual model of OJT capacity. Despite considerable variability in data availability and quality, reasonable indicators are available for the level of mission performance, the quality of mission performance, the amount of training conducted, and the quality of training provided in each of the units.

Consequently, all three basic equations in the conceptual model of OJT capacity have been examined for the aircraft maintenance units

$$ML = f\ (TL, TQ_p, R, E)$$

$$MQ = g\ (ML, TL, TQ, TQ_p, R, E)$$

$$TQ = h\ (ML, TL, R, E)$$

where, once again,

ML = the level of mission performance.

MQ = the quality of mission performance.

TQ = the quality of current training.

TQ_p = the quality of previous training.

TI = the amount of training provided.

R = the resources available to the unit.

E = external, and other, factors.

Only one usable indicator of the level of mission performance has been uncovered for the aircraft maintenance units. This indicator is the ratio of the total number of flying-hours generated by the aircraft maintained by a unit in each month, to the total number of person-days for which enlisted personnel have been assigned to the unit during the month (FLYHRS).

In contrast, 17 different indicators of the quality of mission performance have been developed. To simplify interpretation of the empirical results, each indicator has been formulated so that its value increases as mission performance quality improves. The indicators, their interpretations, and their methods of calculation are

- NGBORTS: the absence of flights aborted before takeoff = 1.0 - (the number of ground aborts in each month/the number of sorties flown during the month).

- NABORTS: the absence of flights aborted after takeoff = 1.0 - (the number of air aborts in each month/the number of sorties flown during the month).

- NBORTS: the absence of aborted flights = 1.0 - (the total number of air and ground aborts in each month/the number of sorties flown during the month).

- NMNTC: the absence of maintenance-related sortie cancellations = 1.0 - (the number of sortie cancellations related to maintenance in each month/the number of sorties flown during the month).

- NMATTR: the absence of maintenance attrition
= 1.0 - maintenance attrition rate in each month.

- NFAIL: the absence of aircraft and component failures
= 1.0 - (the number of aircraft and component failures in each month/the number of sorties flown during the month).

- RR3HR: the 3-hour recovery rate
= the number of aircraft repaired and ready for flight within 3 hours during each month/the number of aircraft requiring maintenance in the month.

- RR6HR: the 6-hour recovery rate
= the number of aircraft repaired and ready for flight within 6 hours during each month/the number of aircraft requiring maintenance in the month.

- MEFFC: the maintenance scheduling effectiveness rate
= a maintenance task accomplishment index developed by the Air Force.

- ONTIME: the ability to take off on schedule
= 1.0 - (the number of late takeoffs in each month/the number of sorties flown during the month).

- SORTYS: the ability to fulfill the programmed flying schedule
= the number of sorties flown as scheduled during each month/the number of sorties scheduled for the month.

- NNMCU: the proportion of aircraft time during which available aircraft are free of essential unscheduled maintenance requirements
= 1.0 - (the total number of hours for which aircraft are not mission capable due to unscheduled maintenance in each month/the total number of hours for which aircraft are available to the unit during the month).

- NMNCUS: the proportion of aircraft time during which available aircraft are free of essential scheduled or unscheduled maintenance requirements
= 1.0 - (the total number of hours for which aircraft are not mission capable due to scheduled or unscheduled maintenance in each month/the total number of hours for which aircraft are available to the unit during the month).

- NPMCM: the proportion of aircraft time during which available aircraft are free of needed, but not essential, maintenance requirements
= 1.0 - (the total number of hours for which aircraft are partially mission capable, but requiring maintenance, in each month/the total number of hours for which aircraft are available to the unit during the month).

- NPCNM: the proportion of aircraft time during which available aircraft are completely free of maintenance requirements
= 1.0 - (the total number of hours for which aircraft are either not mission capable due to maintenance, or partially mission capable but requiring maintenance, in each month/the total number of hours for which aircraft are available to the unit during the month).

- NRCWU: the absence of recurring equipment failures
= 1.0 - (the number of maintenance writeups that recur within the subsequent three sorties, but do not occur on consecutive sorties, in each month/the total number of maintenance writeups in the month).

- BREPR: the base repair rate
= an index developed by the Air Force describing the proportion of maintenance tasks performed on location without external assistance in each month.

Although each of these indicators reflects some aspects of the quality of mission performance attributable to the aircraft maintenance units, none represents a comprehensive and conclusive measure of mission performance quality. Consequently, all 17 indicators have been used in the empirical testing of the conceptual model of OJT capacity for the aircraft maintenance units.

Similarly, three indicators of the quality of training provided by the units have been included in the analysis. One of these indicators assesses the quality of the maintenance work performed by trained personnel; and two appraise the quality of the maintenance practices employed by such personnel while performing the work. The indicators, their interpretations, and their methods of calculation are

- QINSPC: the satisfactory quality of completed maintenance tasks
  = the number of quality verification inspections in which completed tasks are judged satisfactory in each month/the number of quality verification inspections conducted during the month.

- PINSPC: the satisfactory quality of maintenance task performance
  = the number of personnel inspections in which personnel are observed performing tasks satisfactorily in each month/the number of personnel inspections conducted during the month.

- SAFET: the safe performance of maintenance tasks
  = 1.0 - (the number of safety violations detected during personnel inspections in each month/the number of personnel inspections conducted during the month).

All of these indicators are measures of on-the-job performance subsequent to training. Thus, while they are proffered as assessments of training quality, they can be interpreted equally justifiably as indices of mission performance quality. This ambiguity is unavoidable, and should be taken into consideration when interpreting the empirical results.

The amount of training provided in the aircraft maintenance units is also represented by three indicators:

- PTRN: the amount of proficiency training conducted
  = the number of trainees enrolled in UGT to the 5-skill level in each month/the number of 5-, 7-, and 9-skill level personnel assigned to the unit during the month.

- STRN: the amount of supervision training conducted
  = the number of trainees enrolled in UGT to the 7-skill level in each month/the number of 7- and 9-skill level personnel assigned to the unit during the month.

- RE57: the amount of formal training conducted = the number of trainees enrolled in UGT to the 5-skill level and to the 7-skill level in each month/the total number of enlisted personnel assigned to the unit during the month.

As before, these indicators constitute incomplete measures of the OJT loads borne by the units because they fail to reflect informal OJT activities such as qualification training, and they fail to account for any progress achieved by trainees during OJT.

Next, four indicators reflecting the availability of resources to the units have been derived:

- LAMN: shortages in the assignment of enlisted personnel = 1.0 - (the number of enlisted personnel assigned to the unit in each month/the number of enlisted personnel authorized for the unit in the month).

- LSKILL: shortages in the availability of skilled personnel = 1.0 - (the average skill level of the enlisted personnel assigned to the unit in each month/the average skill level of the enlisted personnel authorized for the unit in the month).

- INEXP: the relative inexperience of the enlisted personnel = the number of 3-skill level personnel assigned to the unit during each month/the number of 5-, 7-, and 9-skill level personnel assigned to the unit during the month.

- TRNRS: the availability of professional training personnel = the number of personnel with PAFSC 75XXX assigned to the unit in each month/the total number of enlisted personnel assigned to the unit in the month.

To facilitate direct comparisons with the training load indicators, the first three resource availability indicators have been designed to describe deficiencies in the availability of resources to the aircraft maintenance units. Only TRNRS represents a direct measure of the availability of resources to the units.

Finally, to reflect key aspects of the effects of weather conditions on mission performance and training quality, a dummy variable distinguishing the cold weather months from the other, more temperate months has been included as an indicator of external factors. This variable, SEASON, is set equal to one for each month between November and March, and to zero for each other month, to compensate for the principal seasonal variations in the level and quality of mission performance and the quality of training.

Due primarily to the large number of indicators of the quality of mission performance identified for the aircraft maintenance units, no attempt has been made, during the empirical testing of the conceptual model of OJT capacity for these units, to investigate the direct interactions among the level of mission performance, the quality of mission performance, and the quality of training. Consequently, the relationships actually examined for the aircraft maintenance units have been

$$ML = F\ (TL,\ R,\ E)$$

$$MQ = G\ (TL,\ R,\ E)$$

$$TQ = H\ (TL,\ R,\ E)$$

Moreover, assuming basic linear relationships, the general forms of the equations actually estimated for these units are

$$ML = a + b\ TL + c\ R + d\ E$$

$$MQ = a' + b'\ TL + c'\ R + d'\ E$$

$$TQ = a'' + b''\ TL + c''\ R + d''\ E$$

where ML = FLYHRS.

MQ = NGBORTS, NABORTS, NBORTS, NMNTC, NMATTR, NFAIL, RR3HR, RR6HR, ONTIME, SORTYS, MEFFC, NNMCU, NNMCUS, NPMCM, NPCNM, NRCWU, or BREPR.

TQ = QINSPC, PINSPC, or SAFET.

TL = PTRN, STRN, and/or RE57.

R = LAMN, LSKILL, INEXP, and/or TRNRS.

E = SEASON.

However, inconsistencies among the time periods for which different data series are available, combined with extensive multicollinearity among the explanatory variables, have precluded examination of all conceivable

formulations of the three basic equations. Nevertheless, a total of 91 different formulations of the basic equations, in which mission performance level, mission performance quality, and training quality are related to training load, resource availability, and external factors, have been estimated for the four aircraft maintenance units. These formulations all describe versions of the general equations for which all estimated coefficients are statistically significant at, at least, the 10 percent level. The results of these empirical tests of the fundamental components of the conceptual model of OJT capacity are discussed in the following three subsections.

5.3.1 Mission Performance Level

Eight of the 91 empirical relationships estimated for the aircraft maintenance units have examined the association between the level of mission performance attained by a unit and the training load, resource availability, and external factors affecting the unit. As explained previously, only one usable indicator of the level of mission performance attributable to the aircraft maintenance units has been obtained in this study. The empirical results derived by using multiple linear regression analysis to develop estimates of the relationship between this indicator, FLYHRS, and the various indicators of training load, resource availability, and external factors are presented in Table 8.

These results fail to reveal any consistent or strong association between the level of mission performance achieved by a unit and either the amount of training provided by the unit or -- within the range of resource allotments observed in the study -- the availability of resources to the unit. In only two of the estimated equations are training load variables related statistically significantly to FLYHRS, and in one of these instances, the sign of the estimated coefficient is contrary to prior expectations. Similarly, resource availability variables enter only three of the equations statistically significantly, and on two of these occasions the estimated coefficients have unanticipated signs. This incidence and distribution of statistically significant estimated coefficients can reasonably be expected to occur randomly in the absence of any actual association between the dependent and explanatory variables. Consequently, the empirical results provide no evidence of any interdependency between the level of mission performance, training load, and resource availability -- at least in the low stress, peacetime situations observed in this study.

5.3.2 Mission Performance Quality

A total of 73 equations have been estimated for the aircraft maintenance units to investigate the relationships between each of the 17 indicators of mission performance quality and the various indicators of training loads, resource availability, and external factors. The detailed empirical results of these investigations are presented in Tables A-1 through A-17 of the Appendix.

TABLE 8: Empirical Results of Aircraft Maintenance Unit Regressions with FLYHRS as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	FTRN	STRN	REST	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.0441								-0.0123 (-4.37)[a]	0.313	0.296	19.10 (1,42)[a]
	0.0624							-0.0397 (-1.84)[a]	-0.0107 (-3.05)[a]	0.347	0.278	5.05 (2,19)[a]
2	-0.00275							0.0884 (2.75)[a]		0.308	0.268	7.58 (1,17)[a]
	-0.00137		0.186 (2.20)[a]							0.244	0.194	4.84 (1,15)[a]
3	0.0424								-0.0116 (-2.67)[a]	0.284	0.244	7.14 (1,18)[a]
4	0.0935								-0.413 (-2.27)[a]	0.165	0.133	5.16 (1,26)[a]
	0.0694				0.110 (2.47)[a]				-0.0210 (-3.77)[a]	0.562	0.513	11.55 (2,18)[a]
	0.150			-0.541 (-3.36)[a]						0.414	0.378	11.32 (1,16)[a]

[a]Significantly different from 0 at the 5 percent level.

These results are generally supportive of the hypotheses embodied in the conceptual model of OJT capacity developed in Section 3.0. However, this support is not unequivocal. No statistically significant coefficients have been estimated for any of the training load or resource availability variables in 15 of the 74 equations. Only the external factors variable, SEASON, has been determined to be a statistically significant explanatory variable in these relationships. Moreover, of the 82 statistically significant coefficients estimated for training load and resource availability variables in the remaining 58 equations, 26 have signs opposite to prior expectations.

Nevertheless, a substantial majority -- 68 percent -- of these estimated coefficients exhibit precisely the signs anticipated before the empirical analysis. In addition, the number of statistically significant coefficients estimated for the training load and resource availability variables is considerably larger than the number that would be expected to originate through purely random processes.

Furthermore, separate examination of just the coefficients estimated for the training load variables reveals that training load variables enter 20 of the estimated equations statistically significantly -- and that in 18 of these equations their estimated coefficients exhibit the anticipated signs. Thus, on only two occasions is the sign of an estimated coefficient of a training load variable inconsistent with prior expectations. These results are clearly indicative of a persistent and strong inverse relationship between the amount of training conducted in a unit and the quality of mission performance attributable to the unit.

Yet, these results also indicate that the preponderance of the unanticipated empirical results derived for the aircraft maintenance units must be associated with the resource availability variables. Nevertheless, even for these variables, the number of statistically significant estimated coefficients with signs consistent with prior expectations is substantially greater than the number of such estimates with unanticipated signs. A total of 62 statistically significant coefficients have been estimated for resource availability variables in 49 of the equations examining mission performance quality. Of these 62 coefficients, 38 have the anticipated signs; while only 24 have signs contrary to expectations. With 63 percent of the estimated coefficients exhibiting the expected signs, the empirical results are basically supportive of the presumed relationships between resource availability and the quality of mission performance.

Finally, it is informative to examine separately the relationships estimated for each of the 17 indicators of mission performance quality. Thus, Table 9 presents, for each mission performance quality indicator, the incremental and cumulative frequency distributions of the significance levels of the regression coefficients estimated for the training load variables. Similar distributions for the estimated coefficients

TABLE 9: Distributions of Significance Levels of Training Load Coefficients in Mission Performance Quality Regressions for Aircraft Maintenance Units

Mission Performance Quality Indicator	Frequency Measure	Distribution of Regression Coefficients with Significance Level: 0.01			0.05			0.10		
		Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected
NGBORTS	Incremental	0	0	-	1	0	1.00	0	0	-
	Cumulative	0	0	-	1	0	1.00	1	0	1.00
NABORTS	Incremental	0	0	-	1	0	1.00	1	0	1.00
	Cumulative	0	0	-	1	0	1.00	2	0	1.00
NBORTS	Incremental	0	0	-	1	0	1.00	1	0	1.00
	Cumulative	0	0	-	1	0	1.00	2	0	1.00
NMNTC	Incremental	0	0	-	0	0	-	1	0	1.00
	Cumulative	0	0	-	0	0	-	1	0	1.00
NMATTR	Incremental	0	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
NFAIL	Incremental	0	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
RR3HR	Incremental	0	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
RR6HR	Incremental	0	0	-	1	0	1.00	0	0	-
	Cumulative	0	0	-	1	0	1.00	1	0	1.00
MEFFC	Incremental	1	0	1.00	0	0	-	0	0	-
	Cumulative	1	0	1.00	1	0	1.00	1	0	1.00
ONTIME	Incremental	1	0	1.00	0	0	-	0	0	-
	Cumulative	1	0	1.00	1	0	1.00	1	0	1.00
SORTYS	Incremental	0	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
NNMCU	Incremental	2	1	0.67	1	0	1.00	0	0	-
	Cumulative	2	1	0.67	3	1	0.75	3	1	0.75
NNMCUS	Incremental	1	0	1.00	1	0	1.00	0	0	-
	Cumulative	1	0	1.00	2	0	1.00	2	0	1.00
NPMCM	Incremental	0	0	-	1	1	0.50	0	0	-
	Cumulative	0	0	-	1	1	0.50	1	1	0.50
NPCNM	Incremental	2	0	1.00	1	0	1.00	0	0	-
	Cumulative	2	0	1.00	3	0	1.00	3	0	1.00
NPCMU	Incremental	0	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
BREPR	Incremental	C	0	-	0	0	-	0	0	-
	Cumulative	0	0	-	0	0	-	0	0	-
Total	Incremental	7	1	0.88	8	1	0.89	3	0	1.00
	Cumulative	7	1	0.88	15	2	0.88	18	2	0.90

of the resource availability variables appear in Table 10. Then, aggregate distributions pertaining to the coefficients estimated for both the training load and the resource availability variables are reported in Table 11.

These tables clearly reveal that considerable differences exist among the frequency distributions associated with the various mission performance quality indicators. The signs of the coefficients estimated for some indicators are highly consistent with prior expectations for both the training load variables and the resource availability variables. For other indicators, such consistency is observed only for the training load variables or, in one case, only for the resource availability variables. For the remaining indicators, substantial inconsistency with prior expectations is revealed for both sets of explanatory variables.

Some appreciation of the possible origins of these differences can be gained by considering in greater detail the interpretations of the various mission performance quality indicators. Each of the 17 indicators captures some aspects of the quality of mission performance attributable to the aircraft maintenance units. Yet, there are clear distinctions among the perspectives on mission performance quality provided by the different indicators.

Thus, the first six indicators -- NGBORTS, NABORTS, NBORTS, NMNTC, NMATTR, and NFAIL -- all represent measures of the absolute quality of primary mission performance achieved by the flying wings whose aircraft are serviced by the aircraft maintenance units. For these indicators, in general, the signs of the coefficients estimated for both the training load and the resource availability variables exhibit a high degree of consistency with prior expectations. Only the indicator NFAIL reveals any notable disagreement with anticipation, and even for this indicator, a majority of the estimated coefficients have the expected signs.

The next five indicators -- RR3HR, RR6HR, MEFFC, ONTIME, and SORTYS -- appraise the ability of either the aircraft maintenance units themselves or else the flying wings whose aircraft are maintained on the units, to fulfill predetermined performance schedules or standards. The signs of the estimated training load coefficients associated with these indicators are uniformly identical to the predicted signs. However, considerably less compatibility with prior expectations is observed for the coefficients of the resource availability variables. Only for RR3HR and RR6HR, the variables most clearly and directly related to quality of performance of maintenance activities, do a majority of the coefficients estimated for the resource availability variables have the anticipated signs.

TABLE 10: Distributions of Significance Levels of Resource Availability Coefficients in Mission Performance Quality Regressions for Aircraft Maintenance Units

Mission Performance Quality Indicator	Frequency Measure	Distribution of Regression Coefficients with Significance Level: 0.01 Number as Expected	0.01 Number Unexpected	0.01 Proportion as Expected	0.05 Number as Expected	0.05 Number Unexpected	0.05 Proportion as Expected	0.10 Number as Expected	0.10 Number Unexpected	0.10 Proportion as Expected
NGBORTS	Incremental	0	0	-	1	0	1.00	0	0	-
	Cumulative	0	0	-	1	0	1.00	1	0	1.00
NABORTS	Incremental	1	0	1.00	3	0	1.00	0	1	0.00
	Cumulative	1	0	1.00	4	0	1.00	4	1	0.80
NBORTS	Incremental	0	0	-	2	0	1.00	0	0	-
	Cumulative	0	0	-	2	0	1.00	2	0	1.00
NMNTC	Incremental	1	0	1.00	4	0	1.00	0	0	-
	Cumulative	1	0	1.00	5	0	1.00	5	0	1.00
NMATTR	Incremental	1	0	1.00	0	0	-	0	0	-
	Cumulative	1	0	1.00	1	0	1.00	1	0	1.00
NFAIL	Incremental	1	0	1.00	2	2	0.50	0	0	-
	Cumulative	1	0	1.00	3	2	0.60	3	2	0.60
RR3HR	Incremental	2	1	0.67	2	0	1.00	0	0	-
	Cumulative	2	1	0.67	4	1	0.80	4	1	0.80
RR6HR	Incremental	4	2	0.67	3	0	1.00	0	0	-
	Cumulative	4	2	0.67	7	2	0.78	7	2	0.78
MEFFC	Incremental	0	1	0.00	2	2	0.50	0	0	-
	Cumulative	0	1	0.00	2	3	0.40	2	3	0.40
ONTIME	Incremental	2	0	1.00	0	2	0.00	0	0	-
	Cumulative	2	0	1.00	2	2	0.50	2	2	0.50
SORTYS	Incremental	0	0	-	0	2	0.00	1	0	1.00
	Cumulative	0	0	-	0	2	0.00	1	2	0.33
NNMCU	Incremental	1	0	1.00	0	2	0.00	0	0	-
	Cumulative	1	0	1.00	1	2	0.33	1	2	0.33
NNMCUS	Incremental	0	0	-	0	1	0.00	0	1	0.00
	Cumulative	0	0	-	0	1	0.00	0	2	0.00
NFMCM	Incremental	0	0	-	2	3	0.40	0	0	-
	Cumulative	0	0	-	2	3	0.40	2	3	0.40
NPCNM	Incremental	0	0	-	0	1	0.00	0	1	0.00
	Cumulative	0	0	-	0	1	0.00	0	2	0.00
NRCWU	Incremental	1	1	0.50	0	0	-	0	0	-
	Cumulative	1	1	0.50	1	1	0.50	1	1	0.50
BREPR	Incremental	2	1	0.67	0	0	-	0	0	-
	Cumulative	2	1	0.67	2	1	0.67	2	1	0.67
Total	Incremental	16	6	0.73	21	15	0.58	1	3	0.25
	Cumulative	16	6	0.73	37	21	0.65	38	24	0.63

TABLE 11: Distributions of Significance Levels of Training Load and Resource Availability Coefficients in Mission Performance Quality Regressions for Aircraft Maintenance Units

Mission Performance Quality Indicator	Frequency Measure	Distribution of Regression Coefficients with Significance Level: 0.01			0.05			0.10		
		Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected
NCBORTS	Incremental	0	0	-	2	0	1.00	0	0	-
	Cumulative	0	0	-	2	0	1.00	2	0	1.00
NABORTS	Incremental	1	0	1.00	4	0	1.00	1	1	0.50
	Cumulative	1	0	1.00	5	0	1.00	6	1	0.86
NBORTS	Incremental	0	0	-	3	0	1.00	1	0	1.00
	Cumulative	0	0	-	3	0	1.00	4	0	1.00
NMNTC	Incremental	1	0	1.00	4	0	1.00	1	0	1.00
	Cumulative	1	0	1.00	5	0	1.00	6	0	1.00
NMATTR	Incremental	1	0	1.00	0	0	-	0	0	-
	Cumulative	1	0	1.00	1	0	1.00	1	0	1.00
NFAIL	Incremental	1	0	1.00	2	2	0.50	0	0	-
	Cumulative	1	0	1.00	3	2	0.60	3	2	0.60
RR3HR	Incremental	2	1	0.67	2	0	1.00	0	0	-
	Cumulative	2	1	0.67	4	1	0.80	4	1	0.80
RR6HR	Incremental	4	2	0.67	4	0	1.00	0	0	-
	Cumulative	4	2	0.67	8	2	0.80	8	2	0.80
MEFFC	Incremental	1	1	0.50	2	2	0.50	0	0	-
	Cumulative	1	1	0.50	3	3	0.50	3	3	0.50
ONTIME	Incremental	3	0	1.00	0	2	0.00	0	0	-
	Cumulative	3	0	1.00	3	2	0.60	3	2	0.60
SORTYS	Incremental	0	0	-	0	2	0.00	1	0	1.00
	Cumulative	0	0	-	0	2	0.00	1	2	0.33
NMMCU	Incremental	3	1	0.75	1	2	0.33	0	0	-
	Cumulative	3	1	0.75	4	3	0.57	4	3	0.57
NMMCUS	Incremental	1	0	1.00	1	1	0.50	0	1	0.00
	Cumulative	1	0	1.00	2	1	0.67	2	2	0.50
NPMCM	Incremental	0	0	-	3	4	0.43	0	0	-
	Cumulative	0	0	-	3	4	0.43	3	4	0.43
NPCNM	Incremental	2	0	1.00	1	1	0.50	0	1	0.00
	Cumulative	2	0	1.00	3	1	0.75	3	2	0.60
NPCWU	Incremental	1	1	0.50	0	0	-	0	0	-
	Cumulative	1	1	0.50	1	1	0.50	1	1	0.50
BREPR	Incremental	2	1	0.67	0	0	-	0	0	-
	Cumulative	2	1	0.67	2	1	0.67	2	1	0.67
Total	Incremental	23	7	0.77	29	16	0.64	4	3	0.57
	Cumulative	23	7	0.77	52	23	0.69	56	26	0.68

The next four indicators of mission performance quality -- NNMCU, NNMCUS, NPMCM, NPCNM -- reflect discretionary, and hence to some extent arbitrary, classifications of the reasons for, and severity of, the lack of full mission capability of aircraft requiring maintenance. Although the signs of the training load coefficients derived for these indicators conform reasonably well with prior expectations, it is also true that the only two statistically significant estimated training load coefficients with unanticipated signs appear in equations pertaining to these indicators. Moreover, the resource availability coefficients estimated for these indicators typically have signs opposite to those predicted.

The remaining two mission performance quality indicators -- NRCWU and BREPR -- represent indirect, and somewhat conceptually questionable, measures of the absolute quality of maintenance support provided by the aircraft maintenance units. Thus, the indicator NRCWU does not describe just the recurrence for some aircraft of precisely the same maintenance requirement recently treated by a unit. Rather, it also reflects the occurrence in close succession of unrelated maintenance requirements within the same aircraft component. Similarly, the indicator BREPR not only measures instances in which aircraft maintenance units are unable to accomplish repairs which are normally performed within the units, but also enumerates situations in which, as a matter of policy, units never perform certain repairs internally. Consequently, it is not surprising that, for these two indicators of mission performance quality, no statistically significant relationships are derived for the training load variables, and a substantial portion of the coefficients estimated for the resource availability variables have unanticipated signs.

Thus, in summary, the empirical results derived for the mission performance quality indicators reveal

- A persistent and strong inverse relationship between the amount of training conducted within aircraft maintenance units and most indicators of mission performance quality.

- A somewhat weaker, but demonstrable, association in the anticipated direction between the amount of resources available to the units and the quality of mission performance.

In addition, these results are demonstrated most strongly for the mission performance quality indicators that directly measure the absolute quality of primary mission performance achieved by the flying wings whose aircraft are serviced by the aircraft maintenance units. The more equivocal results are associated with the more questionable indicators of mission performance quality.

5.3.3 Training Quality

The final 10 equations estimated for the aircraft maintenance units examine the relationship between the quality of training conducted in a unit and the training load, resource availability, and external factors affecting the unit. The detailed empirical results derived in these examinations for the three indicators of training quality developed in this study are reported in Tables A-18 through A-20 of the Appendix. In addition, Table 12 presents, for each training quality indicator, the incremental and cumulative frequency distributions of the significance levels of the regression coefficients calculated for the training load variables alone, the resource availability variables alone, and both of these sets of variables in combination.

Overall, these results reveal substantial deviations between the signs estimated for the coefficients of these variables and the signs predicted for these coefficients. Only one-third of the estimated coefficients exhibit the anticipated signs.

Yet, as with the indicators of mission performance quality, noticeable differences exist among the results derived for the different training quality indicators. For QINSPC, the only statistically significant training load coefficient has the expected sign, and the majority of the estimated resource availability coefficients exhibit signs consistent with prior expectations. Conversely, for PINSPC and SAFET, the signs of both coefficients calculated for training load variables, and the signs of virtually all coefficients estimated for resource availability variables, are opposite to the predicted signs.

While these results are unanticipated, a reasonable explanation for their occurrence can be readily deduced by examining the interpretations of the three training quality indicators in greater depth. All of the indicators are based on inspections of maintenance tasks performed not only by recent trainees, but also by experienced enlisted personnel. In addition, the indicators PINSPC and SAFET reflect the results of personnel inspections assessing the extent to which personnel use approved procedures when performing maintenance tasks. Thus, the unexpected signs estimated for the training load and resource availability coefficients in the equations pertaining to PINSPC and SAFET quite possibly result from the application of unconventional, unapproved, and more risky maintenance techniques by the more experienced, more fully trained personnel.

The indicator QINSPC, in contrast, is based on the results of quality verification inspections evaluating the quality of the repairs produced through the performance of maintenance tasks. To the extent that the unconventional maintenance techniques employed by experienced

TABLE 12: Distributions of Significance Levels of Coefficients in Training Quality Regressions for Aircraft Maintenance Units

Explanatory Variables	Training Quality Indicator	Frequency Measure	Distribution of Regression Coefficients with Significance Level: 0.01			0.05			0.10		
			Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected	Number as Expected	Number Unexpected	Proportion as Expected
Training Load	QINSPC	Incremental	1	0	1.00	0	0	-	0	0	-
		Cumulative	1	0	1.00	1	0	1.00	1	0	1.00
	PINSPC	Incremental	0	0	-	0	1	0.00	0	0	-
		Cumulative	0	0	-	0	1	0.00	0	1	0.00
	SAFET	Incremental	0	1	0.00	0	0	-	0	0	-
		Cumulative	0	1	0.00	0	1	0.00	0	1	0.00
	Total	Incremental	1	1	0.50	0	1	0.00	0	0	-
		Cumulative	1	1	0.50	1	2	0.33	1	2	0.33
Resource Availability	QINSPC	Incremental	2	1	0.67	0	1	0.00	1	0	1.00
		Cumulative	2	1	0.67	2	2	0.50	3	2	0.60
	PINSPC	Incremental	0	4	0.00	0	1	0.00	1	0	1.00
		Cumulative	0	4	0.00	0	5	0.00	1	5	0.17
	SAFET	Incremental	0	0	-	0	1	0.00	0	0	-
		Cumulative	0	0	-	0	1	0.00	0	1	0.00
	Total	Incremental	2	5	0.29	0	3	0.00	2	0	1.00
		Cumulative	2	5	0.29	2	8	0.20	4	8	0.33
Training Load and Resource Availability	QINSPC	Incremental	3	1	0.75	0	1	0.00	1	0	1.00
		Cumulative	3	1	0.75	3	2	0.60	4	2	0.67
	PINSPC	Incremental	0	4	0.00	0	2	0.00	1	0	1.00
		Cumulative	0	4	0.00	0	6	0.00	1	6	0.14
	SAFET	Incremental	0	1	0.00	0	1	0.00	0	0	-
		Cumulative	0	1	0.00	0	2	0.00	0	2	0.00
	Total	Incremental	3	6	0.33	0	4	0.00	2	0	1.00
		Cumulative	3	6	0.33	3	10	0.23	5	10	0.33

personnel are quicker or more effective than the approved procedures, the estimated training load and resource availability coefficients will exhibit the predicted signs. Conversely, to the extent that the unconventional maintenance procedures are less efficient than the standard techniques, the signs of the estimated coefficients will be contrary to prior expectations. Therefore, since some of the modified maintenance procedures are likely to be more efficient, and thers will probably be less efficient, than the standard techniques, the mixed results derived for QINSPC seem reasonable.

Finally, it should be remembered that, because the available indicators of training quality all focus on post-training task performance, it is equally reasonable to interpret the indicators as measures of the quality of mission performance. This unavoidable ambiguity should be taken into account when assessing the empirical results as evidence of the appropriateness of the conceptual model of OJT capacity.

5.3.4 Summary

The empirical results derived by estimating the fundamental equations of the conceptual model of OJT capacity for four aircraft maintenance units indicate that

- A consistently strong inverse relationship exists between the amount of training conducted by a unit and the quality of mission performance attributable to the unit.

- A perceptible, but weaker, association in the anticipated direction prevails between the resources available to a unit and the quality of the unit's mission performance.

- The most robust correlations of training load and resource availability with the quality of mission performance are observed for the indicators of mission performance quality that directly measure the absolute quality of primary mission performance achieved by the flying wings whose aircraft are serviced by the aircraft maintenance units.

- A possible association exists between the quality of training provided in a unit and the training load and, conceivably, the available resources of the unit. The most persuasive evidence supporting this relationship is obtained when training quality is measured on the basis of assessments of the results produced through maintenance activities. However, due largely to

limited data availability and ambiguity in the interpretation of the obtainable training quality indicators, the existence of this correlation has not been definitively determined in this study.

- At least in the relatively low stress, peacetime situations examined in the study, no persistent interdependency is discernible among the level of mission performance achieved, the amount of training conducted, and the availability of resources in aircraft maintenance units.

Thus, overall, the empirical analysis of the aircraft maintenance units does not provide unequivocal support for each of the fundamental relationships embodied in the conceptual model of OJT capacity formulated in Section 3.0. Nevertheless, particularly when the limited availability of pertinent data and the ambiguous interpretation of obtainable data are acknowledged, the results of the analysis provide ample support for the basic principle underlying the model -- the principle that the capacity of Air Force operational units to conduct OJT is not unlimited. Rather, it is ultimately determined by the mission responsibility and resource endowments of the units.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Despite severe limitations in the availability of pertinent data from existing sources, a persistent statistically significant relationship has been observed, for all Air Force operational units studied, between the quality of mission performance achieved by a unit and the amount of training conducted in the unit. However, the analytic results only moderately support the possibility of an association between the quality of training provided in a unit and the amount of training performed in the unit; and the evidence concerning the existence of interdependence between the level of mission performance attained by a unit and the training load of the unit is negligible and contradictory.

Nevertheless, especially considering the relatively poor quality of the obtainable data and the absence of several important explanatory variables, the empirical results must be interpreted as extremely favorable indications that an operational methodology for estimating the capacity of Air Force operational units to conduct OJT can ultimately be implemented. Moreover, the results strongly attest that the conceptual model of OJT capacity formulated and preliminarily tested in this study can appropriately and effectively provide the fundamental premises and basic analytic structure for this methodology.

However, the development of an implementable methodology will require further exploratory research, supported by a systematic program of data collection and retention designed to provide a comprehensive set of indicators describing all of the variables contained in the conceptual model. The remainder of this section presents specific recommendations concerning prospective data acquisition and research activities.

6.1 Data Acquisition Recommendations

The validation and calibration of a model of OJT capacity requires historical data. Specifically, for the model formulated in this report, data suitable for creating six different sets of indicators must be acquired. The types of indicators to be created include

- Mission performance level indicators, describing the actions performed by Air Force operational units, and specifying the magnitudes of these actions.

- Mission performance quality indicators, assessing the quality of the outputs directly or ultimately produced through the units' actions. Normally, these indicators will be based on standard quality control measures, such as tabulations of the number of errors committed or the speed of task performance.

- <u>Training load indicators</u>, reporting the total quantity of training conducted within the units, including both currently recorded UGT enrollment and informal activities such as qualification training. In addition, some assessment of trainees' progress in OJT would be desirable.

- <u>Training quality indicators</u>, evaluating the quality of the training conducted in the units, preferably in terms directly relevant to the units' mission responsibilities.

- <u>Resource availability indicators</u>, characterizing the resources allocated to the units for mission performance or training. The resource endowments described should include personnel, equipment, and financial assets. Moreover, if possible, measurements of personnel resources should be partitioned by skill.

- <u>External factors indicators</u>, describing phenomena beyond control of the units that might affect their training or mission performance. Pertinent indicators for many units might include weather conditions, or the diversion of personnel to activities outside the units.

The results derived in the current study clearly demonstrate that, for different types of operational units, the precise forms of the prospectively pertinent indicators for each of the sets listed above will be different. Therefore, to determine the particular data items that must be acquired to create such indicators, it will first be necessary to select the specific types of operational units for which the conceptual model of OJT capacity will be empirically analyzed in the next research effort.

Then, it will be necessary to develop precise definitions of the indicators prospectively pertinent to each of the selected types of units. The definitions should reflect all aspects of each set of indicators believed to affect the units, but should be susceptible to as few extraneous influences or contradictory interpretations as possible.

Next, the definitions should be decomposed to isolate the individual component data items from which the indicators are formed. Thus, for example, ratios should be split into their numerators and denominators, and measures of change over time should be expressed in terms of their underlying data series.

Whenever possible, to minimize the expenditure of time and effort, the resultant desired data elements should then be obtained from established sources. In many instances, the desired data will correspond to information already routinely collected and maintained by the Air Force.

However, in other cases, the data, while regularly collected by the Air Force, may not be retained for a long enough period of time, or may not be preserved in a suitable form, to be readily usable for the proposed analysis. For example, some information may currently be compiled only for the squadron or the flying wing, while tabulations for individual work centers might be needed if the interactions among resources, training loads, and mission performance that, in combination, determine OJT capacity are to be thoroughly investigated. In these situations, revised data recording amd retention procedures should be established to assure the availability of the required information.

Finally, some desired data elements may not presently be collected in any form by any identifiable agency. For these data elements, completely new data acquisition and retention procedures must be established and implemented.

However, for purposes of model validation and calibration, the data acquisition activities outlined previously need not be undertaken universally throughout the Air Force. Rather, a restricted number of operational units of each designated type can be selected to serve as representative prototypes for their general class of units. The established data collection, compilation, and retention procedures can then be applied exclusively to the selected units. Only after the OJT capacity estimation methodology has been fully demonstrated, and the precise data items applicable to this methodology have been determined, should expanded data acquisition procedures be implemented in all operational units.

6.2 Data Analysis Recommendations

The encouraging results derived in this study suggest that further research efforts to validate and calibrate the conceptual model of OJT capacity on the basis of improved data may ultimately prove to be highly beneficial to the Air Force. Specifically, using the information obtained through the data acquisition efforts outlined in the preceding section, empirical estimates of the coefficients of each of the model's basic equations should be derived. Essentially, this involves the estimation of production functions describing the level and quality of mission performance and training provided in individual operational units. Other studies have attested to the difficulty of this task.[16] However, the results produced in this study indicate that such relationships can successfully be established, at least for the factors most pertinent to estimating OJT capacity, and with sufficient accuracy to permit the derivation of satisfactory capacity estimates.

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[16] See, for example, Z. Barzily, W. H. Marlow, and S. Zacks, "Survey of Approaches to Readiness," Naval Research Logistics Quarterly, Arlington, Virginia, Office of Naval Research, March 1979, pp. 21-31.

The empirical analysis to be undertaken in the next research effort can be conducted in either of two ways. First, if the derivation of improved empirical results is desired as quickly as possible, the equations in the conceptual model can be estimated using cross-sectional data describing conditions in a relatively large number of similar operational units during a relatively short period of time. However, this approach implicitly assumes that the functional relationships determining OJT and mission performance are identical in all of these units, but typically does not provide sufficient data to test the validity of this assumption.

Alternatively, the equations in the conceptual model can be estimated using time series data for a smaller number of operational units, but for a longer period of time. Obviously, adoption of this approach will necessarily delay the derivation of improved analytic results. However, it will also permit the direct comparison of the estimated equations derived for similar operational units to test the validity of the assumption that the corresponding functional relationships are identical.

If this assumption is confirmed for any of the sets of operational units examined, a satisfactory OJT capacity estimation methodology could be directly established for these units on the basis of the estimated equations. Conversely, if the empirical results reveal differences among the estimated equations derived for presumably similar units, an investigation should be undertaken to determine the sources of the observed variability. In general, this would entail refinement of the conceptual model, possibly through the inclusion of additional explanatory variables or through respecification of the presumed relationships among variables, to develop a formulation that accounts for the observed differences.

Only if this effort is unsuccessful for some type of operational units will implementation of an OJT capacity estimation methodology applicable throughout the entire Air Force entail separate estimation of the basic equations of the conceptual model of OJT capacity for each individual unit of that type. Moreover, even this task, while obviously onerous and costly, is feasible and potentially beneficial.

In particular, the derivation of satisfactory estimates of the fundamental equations of the conceptual model in the manner discussed above will permit the calculation of theoretically sound estimates of the capacity of operational units to conduct OJT. Development of such OJT capacity estimates will, in general, involve the application of mathematical optimization techniques such as linear programming to derive solutions to constrained maximization problems such as those specified, and illustrated, in Section 3.0. No calculations of this type have been performed in this study because of the severe data limitations confronted for the operational units examined. Any assessments of OJT capacity derived under these circumstances would have been

inconsequential and meaningless. However, improved data and refined estimates of the conceptual model of OJT capacity can reasonably be expected to result in an informative and useful analysis.

Finally, the availability of acceptable estimates of the basic equations of the conceptual model of OJT capacity for a substantial number of operational units will permit the formulation and testing of procedures for estimating the OJT capacities of operational units at higher organizational levels by appropriately aggregating the capacities estimated for lower-level component units. At the extreme, this might entail the development of methodologies, applicable at the base or MAJCOM (Major Command) levels, that use decomposition algorithms to estimate the OJT capacities of the component units. More realistically, it should be possible to account for the interdependencies between higher level and lower level units by developing functional procedures that represent simple extensions of the OJT capacity estimation procedures applicable to the component units. For example, it may be possible to establish factors denoting base and MAJCOM capacity constraints that can be included directly in the OJT capacity estimation methodologies of the lower level units. In any event, the development of satisfactory aggregation procedures will permit the estimation of OJT capacities for virtually any organizational level within the Air Force.

APPENDIX

TABLE A-1: Empirical Results of Aircraft Maintenance Unit Regressions with NGBORTS as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\overline{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.969								-0.0141 (-3.64)[a]	0.240	0.222	13.24 (1,42)[a]
2	0.978					-0.129 (-2.26)[a]				0.231	0.186	5.10 (1,17)[a]
3	0.973								-0.0200 (-4.38)[a]	0.416	0.394	19.22 (1,27)[a]
	1.021			-0.333 (-1.82)[a]					-0.0124 (-2.24)[a]	0.457	0.385	[illegible]32 ([illegible]5)[a]
4	0.975								-0.0112 (-1.75)[a]	0.138	0.093	3.05 (1,19)[b]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-2: Empirical Results of Aircraft Maintenance Unit Regressions with NABORTS as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.998				-0.0429 (-1.76)[a]					0.135	0.091	3.11 (1,20)[b]
2	0.998						-0.0207 (-1.92)[a]			0.178	0.130	3.68 (1,17)[b]
3	0.990								-0.00545 (-2.25)[a]	0.158	0.126	5.05 (1,27)[a]
	0.989				0.0693 (1.46)[b]				-0.00669 (-2.19)[a]	0.306	0.224	3.75 (2,17)[a]
4	0.947	-0.173 (-1.47)[b]					-0.115 (-2.04)[a]	0.210 (2.78)[a]		0.470	0.356	4.14 (3,14)[a]
	0.992								-0.00554 (-1.67)[b]	0.129	0.083	2.80 (1,19)
	1.009		-0.0930 (-2.16)[a]							0.225	0.177	4.65 (1,16)[a]

[a] Significantly different from 0 at the 5 percent level.
[b] Significantly different from 0 at the 10 percent level.

TABLE A-3: Empirical Results of Aircraft Maintenance Unit Regressions with NBORTS as Dependent Variables

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STR..	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.964								-0.0136 (-3.40)[a]	0.216	0.198	11.60 (1,42)[a]
2	0.992						-0.0915 (-2.55)[a]			0.277	0.234	6.50 (1,17)[a]
	0.970					-0.164 (-2.22)[a]				0.248	0.198	4.94 (1,15)[a]
3	0.964								-0.0255 (-4.11)[a]	0.385	0.362	16.90 (1,27)[a]
	1.025			-0.423 (-1.52)[b]					-0.0179 (-2.13)[a]	0.406	0.327	5.13 (2,15)[a]
4	0.967	-0.0167 (-2.04)[a]								0.180	0.137	4.17 (1,19)[b]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-4: Empirical Results of Aircraft Maintenance Unit Regressions with NMNTC as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.938				-0.665 (-2.32)[a]					0.240	0.196	5.38 (1,17)[a]
3	0.945				-0.685 (-2.77)[a]				-0.0337 (-1.98)[a]	0.300	0.246	5.57 (2,26)[a]
	0.939				-0.699 (-2.02)[a]	-1.772 (-2.09)[a]				0.384	0.312	5.31 (2,17)[a]
	1.092		-0.865 (-1.69)[b]		-0.731 (-2.15)[a]					0.374	0.291	4.48 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-5: Empirical Results of Aircraft Maintenance Unit Regressions with NMATTR as Dependent Variable

Unit	Regression Coefficients (and t-statistics)										R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E				
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON				
3	0.887				-0.607 (-2.53)[a]						0.192	0.162	6.41 (1,27)[a]

[a]Significantly different from 0 at the 5 percent level.

TABLE A-6: Empirical Results of Aircraft Maintenance Unit Regressions with NFAIL as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.837				0.261 (2.32)[a]				-0.0252 (-2.95)[a]	0.270	0.234	7.58 (2,41)[a]
2	0.903						-0.163 (-2.36)[a]			0.247	0.202	5.56 (1,17)[a]
	0.864					-0.279 (-1.98)[a]				0.208	0.155	3.94 (1,15)[b]
3	0.893								-0.0386 (-1.89)[a]	0.165	0.119	3.57 (1,18)[b]
	0.0335					1.275 (1.86)[a]		2.006 (4.57)[a]		0.583	0.527	10.47 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-7: Empirical Results of Aircraft Maintenance Unit Regressions with RR3HR as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.0285				-0.425 (-2.18)[a]	-0.656 (-3.87)[a]		0.157 (2.05)[a]	0.0585 (3.82)[a]	0.764	0.696	11.32 (4,14)[a]
3	0.135				-1.941 (-2.90)[a]	8.257 (5.02)[a]				0.629	0.586	14.42 (2,17)[a]

[a]Significantly different from 0 at the 5 percent level.

TABLE A-8: Empirical Results of Aircraft Maintenance Unit Regressions with RR6HR as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.361								-0.0671 (-1.70)[a]	0.064	0.042	2.89 (1,42)[b]
2	0.160					-1.026 (-3.29)[a]		0.280 (2.04)[a]		0.553	0.497	9.89 (2,16)[a]
3	0.269				-2.170 (-3.03)[a]	9.147 (5.20)[a]				0.647	0.605	15.57 (2,17)[a]
	-0.772				-2.722 (-3.86)[a]	11.655 (6.02)[a]		2.484 (1.96)[a]		0.750	0.696	13.99 (3,14)[a]
4	0.421	-0.358 (-2.40)[a]			-0.599 (-2.24)[a]					0.371	0.302	5.32 (2,18)[a]
	0.437				-0.726 (-3.14)[a]				-0.0777 (-2.51)[a]	0.477	0.407	6.84 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-9: Empirical Results of Aircraft Maintenance Unit Regressions with ONTIME as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.972								-0.00990 (-2.48)[a]	0.128	0.107	6.14 (1,42)[a]
	0.959				0.263 (2.44)[a]					0.398	0.332	5.96 (1,9)[a]
2	1.015						-0.203 (-3.08)[a]			0.358	0.320	9.47 (1,17)[a]
3	0.958								-0.0231 (-2.36)[a]	0.171	0.141	5.58 (1,27)[a]
	0.961					-1.315 (-3.20)[a]				0.362	0.326	10.21 (1,18)[a]
	0.417		-1.013 (-4.03)[a]					-0.654 (-2.35)[a]		0.526	0.463	8.32 (2,15)[a]
4	0.966								-0.0129 (-2.12)[a]	0.147	0.114	4.48 (1,26)[a]

[a] Significantly different from 0 at the 5 percent level.

TABLE A-10: Empirical Results of Aircraft Maintenance Unit Regressions with SORTYS as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.771								-0.225 (-5.41)[a]	0.411	0.397	29.26 (1,42)[a]
	1.329							-1.036 (-2.48)[a]	-0.249 (-3.65)[a]	0.444	0.386	7.59 (2,19)[a]
3	0.750								-0.170 (-2.93)[a]	0.241	0.213	8.60 (1,27)[a]
4	0.765								-0.117 (-1.88)[a]	0.119	0.085	3.52 (1,26)[b]
	0.763				-0.855 (-1.72)[b]				-0.139 (-2.24)[a]	0.283	0.203	3.55 (2,18)[a]
	0.609					4.949 (1.96)[a]				0.194	0.143	3.85 (1,16)[b]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

Regressions with MEFFC as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RL57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.928				-0.561 (-2.56)[a]					0.199	0.152	4.22 (1,17)[b]
3	0.715					-1.472 (-1.98)[a]	0.914 (2.94)[a]			0.337	0.259	4.32 (2,17)[a]
	1.367		-1.195 (-2.97)[a]				0.627 (2.49)[a]	-0.864 (-1.94)[a]		0.444	0.325	3.72 (3,14)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-12: Empirical Results of Aircraft Maintenance Unit Regressions with NNMCU as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RES7	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.979							-0.159 (-2.21)[a]		0.223	0.177	4.88 (1,17)[a]
	0.998		-0.500 (-2.36)[a]							0.270	0.222	5.56 (1,15)[a]
3	1.700		-2.029 (-3.62)[a]					-1.375 (-2.20)[a]		0.467	0.396	6.58 (2,15)[a]
4	0.827		-0.191 (-2.55)[a]							0.256	0.216	6.52 (1,19)[a]
	0.959			0.471 (2.88)[a]			-0.956 (-3.14)[a]			0.545	0.485	8.99 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.

TABLE A-13: Empirical Results of Aircraft Maintenance Unit Regressions with NNMCUS as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.788				0.432 (1.99)[a]					0.189	0.142	3.97 (1,17)[b]
3	1.334		-1.413 (-2.58)[a]					-0.915 (-1.49)[b]		0.307	0.215	3.33 (2,15)[b]
4	0.750	-0.221 (-2.76)[a]								0.286	0.249	7.62 (1,19)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-14: Empirical Results of Aircraft Maintenance Unit Regressions with NPMCM as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.946				-0.507 (-1.78)[a]					0.185	0.127	3.18 (1,14)[b]
	0.789							0.286 (2.05)[a]	0.0197 (2.98)[a]	0.590	0.487	5.74 (2,8)[a]
2	1.033		-0.546 (-2.57)[a]				0.189 (2.07)[a]		-0.0395 (-2.55)[a]	0.459	0.335	3.68 (3,13)[a]
3	0.952				0.493 (2.54)[a]				-0.0217 (-1.74)[a]	0.377	0.304	5.15 (2,17)[a]
4	0.807		0.217 (2.17)[a]				0.354 (1.90)[a]			0.359	0.274	4.21 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-15: Empirical Results of Aircraft Maintenance Unit Regressions with NPCNM as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.947		-0.897 (-2.[illegible]							0.272	0.223	5.60 (1,15)[a]
3	1.549		-2.26[illegible] (-3.25)[a]			0.859 (2.18)[a]		-1.178 (-1.49)[b]		0.474	0.361	4.21 (3,14)[a]
4	0.697	-0.228 (-2.71)[a]								0.278	0.240	7.33 (1,19)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-16: Empirical Results of Aircraft Maintenance Unit Regressions with NRCWU as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	IAMN	ISKILL	INEXP	TRNRS	SEASON			
3	0.976				0.193 (3.23)[a]					0.427	0.387	10.45 (1,14)[a]
4	0.923					-1.851 (-3.14)[a]				0.381	0.342	9.86 (1,16)[a]

[a]Significantly different from 0 at the 5 percent level.

TABLE A-17: Empirical Results of Aircraft Maintenance Unit Regressions with BREPR as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.997				-0.108 (-3.23)[a]					0.428	0.387	10.46 (1,14)[a]
3	0.998				-0.0972 (-3.38)[a]					0.449	0.410	11.41 (1,14)[a]
4	0.984				0.207 (3.78)[a]					0.429	0.399	14.29 (1,19)[a]

[a]Significantly different from 0 at the 5 percent level.

TABLE A-18: Empirical Results of Aircraft Maintenance Unit Regressions with QINSPC as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.748					-1.336 (-1.82)[b]				0.293	0.205	3.32 (1,8)
3	0.261					-4.885 (-2.85)[a]	2.359 (3.27)[a]			0.403	0.333	5.74 (2,17)[a]
	1.425			-4.055 (-3.36)[a]	-1.512 (-2.82)[a]					0.479	0.410	6.90 (2,15)[a]
4	0.516						1.088 (2.24)[a]			0.238	0.190	5.00 (1,16)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-19: Empirical Results of Aircraft Maintenance Unit Regressions with PINSPC as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL			R				E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
1	0.908				0.652 (2.32)[a]					0.230	0.187	5.37 (1,18)[a]
3	0.801						0.491 (3.29)[a]		-0.0190 (-2.04)[a]	0.453	0.389	7.04 (2,17)[a]
	0.660						0.443 (2.93)[a]	0.367 (1.52)[b]	-0.0147 (-1.52)[b]	0.568	0.476	6.14 (3,14)[a]
4	0.894				0.530 (5.69)[a]					0.630	0.611	32.38 (1,19)[a]
	0.829		0.297 (1.97)[a]		0.629 (6.58)[a]					0.745	0.711	21.95 (2,15)[a]

[a]Significantly different from 0 at the 5 percent level.
[b]Significantly different from 0 at the 10 percent level.

TABLE A-20: Empirical Results of Aircraft Maintenance Unit Regressions with SAFET as Dependent Variable

Unit	Regression Coefficients (and t-statistics)									R^2	$\bar{R}^2$	F-statistic (and degrees of freedom)
		TL		R					E			
	Constant	PTRN	STRN	RE57	LAMN	LSKILL	INEXP	TRNRS	SEASON			
2	0.923			0.209 (4.71)[a]	0.244 (2.66)[a]					0.801	0.745	14.13 (2,7)[a]

[a]Significantly different from 0 at the 5 percent level.

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AIR FORCE HUMAN RESOURCES LABORATORY (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235

Errata

REPLY TO ATTN OF: TSR

16 JAN 1981

SUBJECT: Removal of Export Control Statement

TO: Defense Technical Information Center
Attn: DTIC/DDA (Mrs Crumbacker)
Cameron Station
Alexandria VA 22314

AD-A091228

1. Please remove the Export Control Statement which erroneously appears on the Notice Page of the reports listed [redacted]. This statement is intended for application to Statement B reports only.

2. Please direct any questions to AFHRL/TSR, AUTOVON 240-3877.

FOR THE COMMANDER

Wendell L Anderson

WENDELL L. ANDERSON, Lt Col, USAF
Chief, Technical Services Division

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List of Reports

Cy to: AFHRL/TSE